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## Travel-related control measures to contain the COVID-19 pandemic: a rapid review (Review)

Burns J, Movsisyan A, Stratil JM, Coenen M, Emmert-Fees KMF, Geffert K, Hoffmann S, Horstick O, Laxy M, Pfadenhauer LM, von Philipsborn P, Sell K, Voss S, Rehfues E

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## [Rapid Review]

# Travel-related control measures to contain the COVID-19 pandemic: a rapid review

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## ABSTRACT

### Background

In late 2019, first cases of coronavirus disease 2019, or COVID-19, caused by the novel coronavirus SARS-CoV-2, were reported in Wuhan, China. Subsequently COVID-19 spread rapidly around the world. To contain the ensuing pandemic, numerous countries have implemented control measures related to international travel, including border closures, partial travel restrictions, entry or exit screening, and quarantine of travellers.

### Objectives

To assess the effectiveness of travel-related control measures during the COVID-19 pandemic on infectious disease and screening-related outcomes.

### Search methods

We searched MEDLINE, Embase and COVID-19-specific databases, including the WHO Global Database on COVID-19 Research, the Cochrane COVID-19 Study Register, and the CDC COVID-19 Research Database on 26 June 2020. We also conducted backward-citation searches with existing reviews.

### Selection criteria

We considered experimental, quasi-experimental, observational and modelling studies assessing the effects of travel-related control measures affecting human travel across national borders during the COVID-19 pandemic. We also included studies concerned with severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS) as indirect evidence. Primary outcomes were cases avoided, cases detected and a shift in epidemic development due to the measures. Secondary outcomes were other infectious disease transmission outcomes, healthcare utilisation, resource requirements and adverse effects if identified in studies assessing at least one primary outcome.

### Data collection and analysis

One review author screened titles and abstracts; all excluded abstracts were screened in duplicate. Two review authors independently screened full texts. One review author extracted data, assessed risk of bias and appraised study quality. At least one additional review author checked for correctness of all data reported in the 'Risk of bias' assessment, quality appraisal and data synthesis. For assessing

the risk of bias and quality of included studies, we used the Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) tool for observational studies concerned with screening, ROBINS-I for observational ecological studies and a bespoke tool for modelling studies. We synthesised findings narratively. One review author assessed certainty of evidence with GRADE, and the review author team discussed ratings.

## Main results

We included 40 records reporting on 36 unique studies. We found 17 modelling studies, 7 observational screening studies and one observational ecological study on COVID-19, four modelling and six observational studies on SARS, and one modelling study on SARS and MERS, covering a variety of settings and epidemic stages.

Most studies compared travel-related control measures against a counterfactual scenario in which the intervention measure was not implemented. However, some modelling studies described additional comparator scenarios, such as different levels of travel restrictions, or a combination of measures.

There were concerns with the quality of many modelling studies and the risk of bias of observational studies. Many modelling studies used potentially inappropriate assumptions about the structure and input parameters of models, and failed to adequately assess uncertainty. Concerns with observational screening studies commonly related to the reference test and the flow of the screening process.

## Studies on COVID-19

### *Travel restrictions reducing cross-border travel*

Eleven studies employed models to simulate a reduction in travel volume; one observational ecological study assessed travel restrictions in response to the COVID-19 pandemic. Very low-certainty evidence from modelling studies suggests that when implemented at the beginning of the outbreak, cross-border travel restrictions may lead to a reduction in the number of new cases of between 26% to 90% (4 studies), the number of deaths (1 study), the time to outbreak of between 2 and 26 days (2 studies), the risk of outbreak of between 1% to 37% (2 studies), and the effective reproduction number (1 modelling and 1 observational ecological study). Low-certainty evidence from modelling studies suggests a reduction in the number of imported or exported cases of between 70% to 81% (5 studies), and in the growth acceleration of epidemic progression (1 study).

### *Screening at borders with or without quarantine*

Evidence from three modelling studies of entry and exit symptom screening without quarantine suggests delays in the time to outbreak of between 1 to 183 days (very low-certainty evidence) and a detection rate of infected travellers of between 10% to 53% (low-certainty evidence).

Six observational studies of entry and exit screening were conducted in specific settings such as evacuation flights and cruise ship outbreaks. Screening approaches varied but followed a similar structure, involving symptom screening of all individuals at departure or upon arrival, followed by quarantine, and different procedures for observation and PCR testing over a period of at least 14 days. The proportion of cases detected ranged from 0% to 91% (depending on the screening approach), and the positive predictive value ranged from 0% to 100% (very low-certainty evidence). The outcomes, however, should be interpreted in relation to both the screening approach used and the prevalence of infection among the travellers screened; for example, symptom-based screening alone generally performed worse than a combination of symptom-based and PCR screening with subsequent observation during quarantine.

### *Quarantine of travellers*

Evidence from one modelling study simulating a 14-day quarantine suggests a reduction in the number of cases seeded by imported cases; larger reductions were seen with increasing levels of quarantine compliance ranging from 277 to 19 cases with rates of compliance modelled between 70% to 100% (very low-certainty evidence).

## Authors' conclusions

With much of the evidence deriving from modelling studies, notably for travel restrictions reducing cross-border travel and quarantine of travellers, there is a lack of 'real-life' evidence for many of these measures. The certainty of the evidence for most travel-related control measures is very low and the true effects may be substantially different from those reported here. Nevertheless, some travel-related control measures during the COVID-19 pandemic may have a positive impact on infectious disease outcomes. Broadly, travel restrictions may limit the spread of disease across national borders. Entry and exit symptom screening measures on their own are not likely to be effective in detecting a meaningful proportion of cases to prevent seeding new cases within the protected region; combined with subsequent quarantine, observation and PCR testing, the effectiveness is likely to improve. There was insufficient evidence to draw firm conclusions about the effectiveness of travel-related quarantine on its own. Some of the included studies suggest that effects are likely to depend on factors such as the stage of the epidemic, the interconnectedness of countries, local measures undertaken to contain community transmission, and the extent of implementation and adherence.

## PLAIN LANGUAGE SUMMARY

### Can travel-related control measures contain the spread of the COVID-19 pandemic?

## What are travel-related control measures?

To contain the spread of COVID-19, numerous countries have implemented control measures related to international travel. These include:

- complete closure of borders (i.e. a total ban on any border crossings);
- partial travel restrictions (e.g. restrictions on air travel only, or restrictions on travellers from certain countries);
- entry or exit screening (e.g. when travellers are asked about symptoms, examined physically, or tested for infection when leaving or entering a country);
- quarantine of travellers (e.g. when travellers have to stay at home or at a specific place for some time after crossing a border).

Some countries implemented similar travel-related control measures during the recent outbreaks of two related diseases, severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS).

## What did we want to find out?

We wanted to find out how effective travel-related control measures are in containing the COVID-19 pandemic. We also wanted to know about the costs of the measures and what effect they have on healthcare and other resource use, as well as potential negative effects, such as feeling isolated.

## What we did

We searched for studies on the effects of travel-related control measures on the spread of COVID-19, as well as on SARS and MERS to provide supporting information. Studies had to report how many cases (people with infection) the measures prevented or detected, and whether the measures changed the course of the epidemic. Studies could include people of any age, anywhere. They could be of any design including studies that used 'real-life' data (observational studies) or hypothetical data from computer-generated simulations (modelling studies).

We included studies published up to 26 June 2020.

## What we found

We found 25 studies on COVID-19, 10 on SARS and one on both SARS and MERS. Studies took place across the world except for Africa and the eastern Mediterranean.

Twelve studies (11 modelling studies, 1 observational study) on COVID-19 found that restricting cross-border travel at the beginning of an outbreak may reduce new cases by a minimum of 26% to a maximum of 90%, may reduce the number of deaths, may reduce the time to an outbreak by between 2 to 26 days, and may reduce the spread and risk of an outbreak. There was also a reduction in imported or exported cases and in growth of the epidemic.

We found 12 studies (6 modelling studies, 6 observational studies) on entry or exit screening, with and without quarantine, to contain the spread of COVID-19. Based on data from three modelling studies, there may be a delay in the time to an outbreak, and between 10% to 53% of infected travellers would be detected. However, the results from the observational studies varied considerably, and we are uncertain about the proportion of people identified accurately as having COVID-19 from these studies.

Only one modelling study examined quarantine measures for COVID-19. It found fewer new cases due to imported cases where 14-day quarantine was in place.

## How reliable are these results?

Our confidence in these results is limited for several reasons. Most studies were not based on real-life epidemics but on mathematical predictions. Their results depended on the assumptions that they made, not on real-life data. Also, the studies were very different from each other and their results would probably vary according to the stage of the epidemic, the amount of cross-border travel, other measures undertaken locally, and the extent of implementation and enforcement. Results of entry and exit screening studies might vary according to the screening method used and the level of infection among travellers. Also, some studies were published as 'preprints', which means they did not undergo the rigorous checks of most peer-reviewed studies.

## What this means

Overall, travel-related control measures may help to limit the spread of disease across national borders. Cross-border travel restrictions are probably more effective than entry and exit screening. Screening is likely to be more effective if combined with other measures, such as quarantine and observation. We found very little information on travel-related quarantine as a stand-alone measure and no information on costs or negative effects.

## BACKGROUND

### Description of the condition

The first case of the novel coronavirus disease 2019 (COVID-19) was reported in Wuhan (Hubei province of China) in late 2019. Over the following weeks, the disease spread further into China and countries of Asia, including Japan, South Korea, and Thailand (WHO 2020a). Close to mid-March, cases had been reported in over 100 countries across the globe, and on 11 March 2020, the World Health Organization (WHO) declared the outbreak a global pandemic (WHO 2020b).

COVID-19 is caused by SARS-CoV-2, a virus closely related to those of the coronaviruses causing severe acute respiratory syndrome (SARS-CoV-1/SARS) and Middle East respiratory syndrome (MERS-CoV/MERS). However, in comparison with these viruses, SARS-CoV-2 has higher transmissibility and lower pathogenicity (Fani 2020). Most people infected with SARS-CoV-2 have mild disease with unspecific symptoms (Wu 2020). The proportion of cases critically ill, with respiratory failure, septic shock, multiple organ failure, or a combination of two or all of these, has been reported as 5% in China (Wu 2020). Although long-term research is still lacking, there is also an increasing number of early reports of longer-lasting morbidity, including lung damage, but also neurological and vascular damage, similar to SARS. It is estimated that between 4% to 41% of infected individuals never develop symptoms (Byambasuren 2020), and both pre-symptomatic and asymptomatic transmission has been described and is likely to play an important role in the dynamics of the pandemic (Furukawa 2020).

A range of non-pharmacological interventions (NPIs) have been put into place by governments to contain and mitigate the spread of COVID-19. Given the lack of a drug or vaccine to prevent SARS-CoV-2 infection and only limited pharmacological interventions to treat COVID-19, NPIs will continue to play a critical role in containing the SARS-CoV-2 pandemic for a significant period of time to come. Travel-related control measures, one important type of NPI, range from the screening of travellers entering or leaving a country to the complete closure of national borders. Starting from February 2020, many countries and regions in the world have implemented some type of travel-related control measure, and these continue to be implemented across many countries. As the pandemic continues across the globe, with some countries reporting beginning a second wave of infections (Strzelecki 2020), it is crucial to understand the effectiveness of these measures, including at what point in an outbreak they should be implemented and when they can be relaxed. Such knowledge will help inform decisions on their (re)implementation, relaxation or suspension, as well as potential modifications and guide public health resource allocation. This is in line with the International Health Regulations 2005 calling to ground public health decision-making in scientific evidence (WHO 2005).

### Description of the intervention

Travel-related control measures comprise different interventions, including the complete closure of national borders to entry or exit, or both; full or partial travel restrictions across borders (e.g. denial of entry or exit on the basis of nationality, travel history, health status or other characteristics, suspension of travel via land, air and sea); entry and exit screening at borders based on symptoms

or testing; and quarantine of travellers. These measures can be implemented for all modes of travel, including air, land, and sea.

Travel-related public health measures have a long tradition as a means of preventing the spread of epidemic diseases. Historic examples include the prevention of the spread of bubonic plague through widespread travel-related quarantine in medieval port towns and other locations (Tognotti 2013). More recently, entry screening at national borders was implemented during the SARS epidemic in 2003, and airport exit screening measures were used in efforts to contain the Ebola epidemic in West Africa and the Democratic Republic of Congo in 2014 to 2016 (Mouchtouri 2019).

In 2019, WHO developed guidelines on non-pharmaceutical public health measures for mitigating the risk and impact of epidemic and pandemic influenza. Based on a systematic review of the evidence, internal (i.e. sub-national) travel restrictions were among the measures recommended during early stages of extraordinary, localised influenza pandemics, while entry and exit screening were not recommended due to overall ineffectiveness of the measure, and border closures were not recommended, unless required by national law or in extraordinary circumstances (WHO 2019). However, the transmission characteristics of influenza are different from those of SARS-CoV-2 and these insights are therefore not directly applicable to SARS-CoV-2. More directly relevant, two reviews assessed the effectiveness of travel-related control measures in the context of the SARS, MERS and other infectious disease epidemics (Errett 2020). One review reports that effectiveness was limited, as few infected travellers were identified; however, the review finds secondary potential benefits, such as raising awareness and discouraging sick individuals from travelling (Mouchtouri 2019). The second review examined the impact of travel reductions on the spread of infectious diseases other than influenza, and concluded that these had some success in reducing infectious disease spread across countries but did not halt transmission. The review also emphasised the potentially high social, economic, and political cost of travel bans (Errett 2020). Undertaken in the context of the ongoing SARS-CoV-2 pandemic, a Cochrane rapid review examined the effectiveness of traveller quarantine amongst other quarantine measures, finding very low-certainty evidence for a small effect for travellers from countries with a declared outbreak (Nussbaumer-Streit 2020). This review is currently being updated.

Thus, the evidence regarding the effectiveness of travel-related control measures to prevent infectious disease spread is mixed and incomplete. Importantly, given the different transmission characteristics of influenza and the likely high rate of asymptomatic transmission for SARS-CoV-2 as compared to SARS-CoV-1 or MERS-CoV, many of the insights gained from these other pathogens are not directly transferable. Thus, a systematic review of the effectiveness of travel-related control measures including the emerging evidence base from the current pandemic is warranted.

### How the intervention might work

Travel-related control measures limit the mobility of potential human carriers of infection when crossing national (and, in principle, also sub-national) borders. These restrictions can be imposed on travellers arriving or leaving via land, air, or sea and are usually implemented by governmental bodies. The main idea behind all of these measures is to prevent the introduction of an infectious agent (in the case of our review SARS-CoV-2, SARS-CoV-1

or MERS-CoV) into a country or to reduce or delay the spread of an infectious disease within a country, or both. The intervention thus seeks to achieve a shift in epidemic development, whether by avoiding the epidemic entirely (i.e. cases do not occur at all), by reducing the peak of the epidemic (i.e. fewer cases occur, or are spread over a longer time period) or by delaying the arrival or peak of the epidemic (i.e. cases occur later).

All travel-related control measures are based on the notion that travellers (all travellers or those from specific regions or with specific characteristics) represent a population at risk of being infected and of spreading the infection. For SARS-CoV-2, the risk of an infected person travelling and being unaware of being infected is compounded by the fact that pre-symptomatic and asymptomatic transmission is likely to play an important role. The intervention works by:

- stopping travel of such high-risk individuals altogether (i.e. complete border closure or travel ban);
- limiting the number of high-risk individuals entering or exiting a country (i.e. travel restrictions);
- detecting infected individuals based on symptoms or testing for the virus (i.e. entry and exit screening); and
- preventing disease transmission until a person has been clearly identified as non-infectious (i.e. quarantine).

In light of the high rates of pre- and asymptomatic transmission, certain travel-related measures may be more appropriate in the SARS-CoV-2 pandemic than others. For example, travel quarantine may prove more effective than entry and exit screening.

In addition to their intended positive impact on infectious disease dynamics, travel-related control measures may also have negative health impacts, notably the well-known side effects of quarantine and isolation on mental health. Moreover, they have far-reaching economic, social, legal, ethical, and political implications (Folayan 2015; Nuttal 2014; Nuzzo 2014).

## OBJECTIVES

To assess the effectiveness of travel-related control measures during the COVID-19 pandemic on infectious disease and screening-related outcomes.

## METHODS

In May 2020, WHO requested the review authors to develop an evidence map charting the evidence of various travel-related control measures relevant for containing the COVID-19 pandemic. The map identified 122 studies assessing a range of measures undertaken across the globe to address COVID-19, SARS, MERS, and influenza. Studies used methods ranging from simple observational approaches to complex modelling techniques (Burns 2020). This map informed the scope of and methodological considerations regarding this rapid review.

The methods for this rapid review were prespecified in a protocol that was submitted to and reviewed by Cochrane (see Appendix 1); eligibility criteria were reviewed and agreed upon with WHO. To conduct this rapid review, we employed abridged procedures of systematic reviewing at certain stages, according to the Cochrane guidance for rapid reviews (Garritty 2020). Specifically, only one review author conducted data extraction, assessment of risk of bias

of epidemiological studies and quality assessment of modelling studies. At least one additional review author, and in most cases two additional review authors, checked for correctness of all data reported in the 'Risk of bias' assessment, quality appraisal and data synthesis, and three or more review authors discussed any uncertainties. To ensure that the abridged procedures did not compromise the methodological rigour of the review, but also to ensure that all stages of the review are conducted consistently and correctly, we assigned these data extraction, risk of bias and quality assessment tasks to experienced Cochrane review authors and involved researchers with modelling expertise to assist with the data extraction and quality assessment of modelling studies. Furthermore, we piloted the procedures for each stage, conducted regular team meetings and kept a list of rolling questions that were updated continually.

## Criteria for considering studies for this review

### Study design

In the context of a global pandemic, evidence to inform decisions must be generated rapidly, meaning that methods traditionally used to evaluate impact, such as randomised controlled trials (RCTs) or quasi-experimental studies, while possible, may not be considered feasible, appropriate, timely or ethical. Indeed, in this specific context, models developed to make predictions about the (highly uncertain) future often represent the only available evidence to inform decision making. To ensure that we captured all relevant study types, we considered a broad range of empirical studies of any size that provided a quantitative measure of impact, including experimental and quasi-experimental studies, observational studies, and epidemiological and mathematical modelling studies.

- Experimental and quasi-experimental studies, such as
  - \* RCTs
  - \* interrupted time series (ITS) studies
  - \* controlled before-after (CBA) studies and difference-in-differences (DiD) studies
  - \* instrumental variable (IV) studies
  - \* regression discontinuity (RD) studies
- Observational studies, such as
  - \* cohort studies
  - \* case-control studies
- Modelling studies, such as
  - \* compartmental models (e.g. SEIR-type models comprising multiple compartments, such as S: susceptible, E: exposed, I: infectious, R: recovered)
  - \* Bayesian hierarchical models (i.e. models comprising several sub-models to integrate observed data as well as uncertainty)
  - \* spatial models (i.e. modelling disease transmission spatially)
  - \* time-series models (i.e. models that model the temporal nature of disease transmission using time-series techniques)

To avoid the inappropriate exclusion of studies, we considered all studies providing a quantitative measure of impact, regardless of whether they were indicated by any of these labels. We considered studies published in journals as well as those published on preprint servers. Indeed, in the context of a global pandemic, there may be a scientific as well as moral case for publishing modelled predictions

at the earliest opportunity to inform the emergency response. We included any RCTs that had been registered but not yet published (in a peer-reviewed journal or on a preprint server) as 'ongoing' studies.

We excluded the following types of studies and publications:

- case reports
- studies that did not provide a quantitative measure of impact (e.g. studies providing a graphical summary of the development of the number of cases over time in relation to the introduction of control measures, qualitative studies)
- diagnostic studies (e.g. assessing the sensitivity and specificity of different screening tests in general; we did, however, include studies on the use of screening tests at national borders as a travel-related control measure)
- non-empirical studies (e.g. commentaries, editorials, non-systematic literature reviews not reporting primary empirical data)
- systematic reviews (although relevant reviews were used for backward citation searches, including our previous evidence map)
- conference abstracts

## Population

We included studies on human populations (without any age restriction) susceptible to SARS-CoV-1/SARS, SARS-CoV-2/COVID-19, and MERS-CoV/MERS. To be eligible, modelling studies had to use modelling parameters for disease transmission specified to reflect one of these diseases.

We excluded studies:

- not targeting human transmission;
- concerned with humans at risk of developing other infectious diseases characterised by different transmission properties (e.g. Ebola and viral meningitis, the transmission mode of which is primarily person-to-person rather than airborne);
- addressing humans at risk of developing other infectious diseases, for which travel-related control measures do not play a significant role in containing outbreaks (e.g. influenza).

## Intervention

We considered travel-related control measures affecting human travel across national borders. We considered both introduction and implementation, as well as relaxation and de-implementation of the following measures.

- Closure of national borders to entry or exit, or both
- International travel restrictions or bans, or both
  - \* Denial of entry or exit, or both, on the basis of nationality, travel history, health status or other characteristics
  - \* Full or partial suspension of cross-border travel via any or all of land, air and sea
  - \* Visa requirement or refusal on the basis of nationality, travel history, health status or other characteristics

- Entry and exit screening at national borders
  - \* Temperature measurement (e.g. thermography)
  - \* Health questionnaire (e.g. symptoms, travel history, contact history)
  - \* Physical examination
  - \* Testing for current or past infection
  - \* Passive observation
- Quarantine or isolation of travellers crossing national borders
- Any combination of the above measures

We excluded the following types of interventions.

- Combinations of the above mentioned travel-related control measures with other measures where studies do not provide effect estimates for the travel-related control measures (e.g. studies providing a combined effect estimate for suspension of cross-border travel and use of mandatory face masks in the general population). Studies, in which the effect of travel-related control measures cannot be disentangled from the effect of a broader suite of public health measures, cannot usefully inform WHO recommendations on whether countries should or should not consider travel-related control measures to contain the COVID-19 pandemic (see review objective).
- All interventions not directly related to travel, including a range of containment and mitigation measures (e.g. community-based quarantine, personal protective measures, hygiene measures, bans on mass gatherings and other social-distancing measures).
- All interventions related to movement of animals or goods.
- All interventions concerned with human travel across sub-national borders. While sub-national measures can potentially inform national travel-related control measures, these measures are not prioritised by the WHO, and as shown in the previous evidence map (Burns 2020), are often impossible to disentangle from other sub-national measures, such as lockdowns, community quarantine or social distancing recommendations.
- Travel warnings or travel advice issued by the WHO or national governments.
- Interventions solely concerned with the accuracy of tests rather than their implementation as part of an entry and exit border control measure
- Usual practice (e.g. seasonal changes to travel) or events (e.g. school holidays) affecting travel but not representing travel-related control measures.
- Cancellation of events affecting international travel but undertaken as a means to prevent mass gatherings (e.g. Hajj, international sporting events, international trade fairs).

## Other considerations

There are two Cochrane rapid reviews with which we identified overlapping studies. One published review, which is currently being updated, focuses on quarantine measures, including quarantining travellers crossing national borders (Nussbaumer-Streit 2020). The other review (currently under review) is concerned with screening measures, including entry and exit screening at national borders (Viswanathan 2020). In discussions with Cochrane and WHO, we decided that it would be important for decision-makers to be able to access the evidence on all travel-related control measures in a

single review. To address the overlap between the present review and the two separately conducted reviews, we checked our review findings with the findings from those reviews. While we identified a few overlapping studies, these are presented and discussed as part of different bodies of evidence and in relation to different scopes, and therefore we did not identify any discrepancies in reporting and interpretation. Along with our previous evidence map on travel-related control measures (Burns 2020), we considered these reviews for backward citation searches.

### Comparator(s)

We included all possible comparators. A travel-related control measure could have been compared against, for example, a counterfactual scenario in which the intervention was not implemented, a complete relaxation of the measure, or a partial relaxation of the measure. Likewise, a scenario of no intervention could have been compared against a counterfactual scenario in which an intervention was implemented or relaxed.

### Outcome(s)

#### Primary outcomes

We considered studies assessing any of the following infectious disease transmission and screening-related outcomes.

- Cases avoided due to the intervention: (e.g. number, proportion, rate of cases observed or predicted with and without the intervention)
- Number of cases detected due to the intervention: we focused on outcomes we felt are most relevant for decision-makers in the current pandemic; specifically, we considered outcomes measuring the proportion of cases detected per the total number of cases (i.e. sensitivity, case detection rate) and the proportion of cases among those identified as high risk (i.e. the positive predictive value).
- Shift in epidemic development due to the intervention: (e.g. probability of epidemic, time to/delay in epidemic arrival or peak, size of epidemic peak, change in the effective reproduction number).

#### Secondary outcomes

We considered the following secondary outcomes if identified in studies that assessed at least one of the primary outcomes.

- Any other infectious disease transmission outcomes
- Healthcare utilisation (e.g. number of cases requiring treatment in the intensive care unit (ICU), time until ICU capacity is reached)
- Resource requirements for implementing the intervention (e.g. costs associated with intervention, additional personnel, number of tests required)
- Any adverse effects (e.g. health, economic, and social outcomes)

We did not consider studies reporting only on other outcomes.

### Search methods for identification of studies

The search strategy was structured around two blocks focusing firstly on COVID-19, SARS and MERS, and secondly on travel-related control measures. We conducted the searches in English but aimed to include studies published in any language. We adapted the search strategy used in the evidence map for travel-related control

measures (Burns 2020). An experienced information specialist adapted and ran systematic searches, which were verified by a content expert and reviewed by Cochrane.

### Electronic databases

We ran searches in the following electronic databases on 26 June 2020.

- Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Daily and Versions(R) (1946-present)
- Ovid Embase (1996-present)

### Other searches

We additionally searched the following COVID-19-specific databases.

- Cochrane COVID-19 Study Register ([covid-19.cochrane.org](https://covid-19.cochrane.org)), which contains study references from ClinicalTrials.gov, WHO International Clinical Trials Registry Platform (ICTRP), PubMed, medRxiv and other handsearch articles from publishers' websites.
- WHO COVID-19 Global literature on coronavirus disease ([search.bvsalud.org/global-literature-on-novel-coronavirus-2019-ncov](https://search.bvsalud.org/global-literature-on-novel-coronavirus-2019-ncov)), which contains primarily research (published and/or prepublication) journal articles from PubMed, Web of Science, Global Index Medicus, Embase. In addition, Lanzhou University submits citations on a daily basis from the China National Knowledge Infrastructure (CNKI) as well as a number of Chinese journal publishers.
- Centers for Disease Control and Prevention (CDC) COVID-19 Research Articles Downloadable Database ([www.cdc.gov/library/researchguides/2019novelcoronavirus/researcharticles.html](https://www.cdc.gov/library/researchguides/2019novelcoronavirus/researcharticles.html)), searched exclusively for preprints from bioRxiv, medRxiv and SSRN.

Finally, we screened the reference lists of the systematic reviews on travel-related control measures found through our searches (see [Appendix 2](#)), to identify additional eligible studies. The full search strategy is presented in [Appendix 3](#).

### Data collection and analysis

#### Selection of studies

We developed guidance for screening titles and abstracts. To harmonise the screening process, we had all review authors involved with the title and abstract screening screen an initial set of approximately 100 studies after which we organised a group call to discuss any issues and revise the guidance. One review author screened the titles and abstracts of all the records identified. Following this, a second review author screened all the records excluded by the first review author. We adopted an inclusive approach at this stage, and all unclear studies were taken forward to full-text screening. Screening all full texts in duplicate, as described below, ensured that the single screening of titles and abstracts included at this stage did not compromise methodological rigour. The team conducted title and abstract screening using Rayyan (Ouzzani 2016).

As with the title and abstract screening process, we harmonised the full-text screening process by having all review authors involved with full-text screening screen at least 10 studies at the outset of this

stage ([Garritty 2020](#)). The team then discussed any open questions or issues in a group call, and accordingly revised the guidance. Subsequently, two review authors working independently each screened the remaining full-text records in duplicate. The two review authors discussed any discrepancies, and consulted a third review author or the entire author team where necessary until they reached consensus. We recorded reasons for exclusion for all studies excluded at the full-text screening stage.

### ***Inclusion of non-English language studies***

We considered studies published in all languages. Within the review team, we were able to consider studies in Armenian, English, French, German, Italian, Russian and Spanish, and would have sought help with translation for any other languages. We screened a small number of studies in other languages at the title and abstract screening stage, including some with an English abstract and some written in German and Spanish, however, we did not identify any relevant studies in any languages other than English.

### **Data extraction and management**

One review author extracted study characteristics and data from all included studies using a data extraction form in Microsoft Excel. All extracted data were checked by a second review author. We piloted the data extraction form using five studies representing different intervention types and study designs meeting the inclusion criteria. [Appendix 4](#) provides the details on the data extraction categories.

In the review protocol (see [Appendix 1](#)), we specified that we would consider searching for data from external sources to enhance our understanding of the design features of the travel-related control measures and the stage of the pandemic at the time these were implemented. However, given lack of comprehensive reporting and consistency of the information provided across these sources (e.g. discrepancies in how WHO reports described the stage of the pandemic in earlier months), and given that this information was largely not applicable to modelling studies, we decided against using these sources.

### **Assessment of risk of bias in included studies**

One review author rated the risk of bias or quality of each included study, depending on the type of study, and a second review author checked these ratings. The review authors primarily involved with assessing risk of bias and quality discussed how to correctly and consistently apply each of the tools to a set of studies before beginning the assessment (one screening study and four modelling studies). These review authors discussed any questions or uncertainties that arose during the process between themselves or among the review team.

Given the broad range of study designs, we applied multiple tools in assessing the risk of bias or quality of included studies. We had planned to use version 2 of the Cochrane 'Risk of bias' tool for experimental studies ([Higgins 2019](#)), and ROBINS-I for quasi-experimental and observational intervention studies ([Sterne 2016](#)). We identified only one observational ecological study; although ROBINS-I was developed specifically for cohort-type study designs and not for this type of study, we considered the tool a reasonably appropriate tool for assessing the risk of bias.

When viewing our list of included studies, we realised that several studies evaluating entry and exit screening measures

were more closely related to diagnostic studies than intervention evaluations; for example, these studies report on the number of individuals screened (i.e. those that received an index test), the number positively screened as high risk and the number ultimately diagnosed (i.e. those that received a reference test). To appropriately assess the risk of bias of such studies, we decided post-protocol to apply the Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) tool ([Whiting 2011](#)), as also employed in the Cochrane review on screening measures to control COVID-19. This tool comprises four domains: participant selection (i.e. passenger/traveller selection, for our purposes), the index test, the reference standard, and the flow and timing. For each of these domains, using a series of signalling questions, we provided a judgment of 'low', 'unclear' or 'high' risk of bias for each study. Additionally, the tool facilitates a concrete assessment of generalisability, through considering how the population, index test and reference standard compares with the aspects of interest in this review. In line with QUADAS-2 guidance, we considered how best to apply the tool to our specific review question; the tool, including the specifications we applied in making judgements, is outlined in [Appendix 5](#).

No validated tool is available for assessing the risk of bias of modelling studies, and little consensus exists in the systematic review community about how best to approach the assessment of risk of bias or quality, or both, of an individual modelling study. A rapid review of the methodological literature aimed to identify and summarise studies describing criteria for assessing the quality of mathematical studies ([Egger 2017](#)). This review identified 20 studies (including [Caro 2014](#) and [Philips 2006](#)), that varied in scope and level of detail regarding the proposed criteria. Looking across the identified studies, it suggested that an assessment of the quality of a modelling study should capture the aspects of:

- model structure;
- input data;
- different dimensions of uncertainty;
- transparency; and
- validation.

Following the suggestions by [Egger 2017](#), we developed a bespoke tool for the assessment of modelling studies and selected single criteria from three studies ([Errett 2020](#); [Caro 2014](#); [Philips 2006](#)). We sought to strike a balance between capturing all five key aspects and the feasibility of applying the criteria. We slightly adapted the criteria for input data, internal and external validity post-protocol but did not alter the overall structure or scope of the tool. For input data, this resulted in splitting one criterion into two, allowing for the assessment of whether the input data are transparently reported and whether they are appropriate (consistent with the criteria for structural assumptions). For model validation, this involved combining two criteria related to external validity into one, and likewise two criteria related to internal validity into one. We did so because, while piloting the tool, we realised that most included studies did not conduct an external or internal validity assessment, and those that did were not reported to the extent envisioned by the original criteria. This led to mostly empty assessments, without the ability to satisfactorily distinguish between those that did not assess external or internal validity at all, and those that did, even if this assessment was somewhat limited. The individual criteria we applied, in the form of signalling questions, are outlined in [Appendix 6](#). We reported each of the criteria separately, that is,

we did not combine multiple criteria into a summary score. This also allows for a distinction between 'fatal flaw indicators', notably inappropriate structural assumptions and input parameters, and other aspects of model quality and credibility, such as internal and external model validation (Caro 2014). One review author checked the quality of modelling studies and a second review author checked the judgements..

### Contacting study authors

We contacted study authors to request additional information where unclear or non-reported aspects precluded the assessment of eligibility or the inclusion in the data synthesis.

### Data synthesis

We synthesised the findings narratively and in tabular form, stratified by outcome, disease and intervention type; we adhered to the 'Synthesis without meta-analysis (SWiM) in systematic reviews': reporting guideline (Campbell 2020). Given that observational studies provide a measured estimate of effect whereas modelling studies predict such an effect, we treated these as two separate bodies of evidence (see also Assessment of certainty of evidence). Due to substantial heterogeneity across included studies with regard to the setting, population, intervention and other contextual factors, as well as study methods, and as specified in the protocol (Appendix 1), we decided that data were not sufficiently similar to conduct meta-analyses.

When viewing our list of included studies, we realised that several studies evaluating entry and exit screening measures and meeting our eligibility criteria did not include sufficient data to fully inform the data synthesis. These studies report, for example, how many individuals have been screened, how many were screened positively, and how many were cases; however, due to the lack of a reference test, the true number of cases is completely unknown. As a result, these studies provide information on how many cases were detected, however not on how many cases were missed. Therefore, we made the post-protocol decision to classify these studies as 'supporting studies', and to describe their results descriptively. They were therefore not included in the data synthesis or certainty of evidence rating.

### Assessment of heterogeneity and subgroup analyses

In the absence of meta-analyses, and given the substantial heterogeneity of included studies, we did not conduct analyses of subgroups. Instead, we discuss relevant sources of heterogeneity within modelling studies and across studies making up a specific body of evidence narratively.

### Assessment of certainty of evidence

We used the GRADE approach to assess the certainty of the primary outcomes. One review author collated the evidence for each primary outcome and suggested initial certainty of evidence ratings. These were then further deliberated in a team of review authors and a joint decision for certainty of evidence ratings was made for each primary outcome.

The certainty of evidence is defined in GRADE as the extent to which one can be confident that the true effect of an intervention lies on one side of a specified threshold, or within a chosen range (Hultcrantz 2017). In this rapid review, we considered 'difference from the null' as an important threshold, assuming that even small

effect sizes may be relevant for population-level travel-related control measures.

The certainty of evidence rating in GRADE yields four possible levels of evidence: high certainty (i.e. the estimated effect lies close to the true effect), moderate certainty (i.e. the estimated effect is probably close to the true effect), low certainty (i.e. the estimated effect might substantially differ from the true effect), and very low certainty (i.e. the estimated effect is probably substantially different from the true effect).

In accordance with our approach to data synthesis, we rated bodies of evidence from observational and modelling studies separately. In GRADE, evidence from RCTs enters the rating as high certainty, as does evidence from observational studies whose risk of bias has been assessed using ROBINS-I (Schunemann 2019). Subsequently, five domains are used to downgrade evidence, including study limitations, inconsistency, indirectness, imprecision and publication bias, and three domains are used to upgrade evidence, including plausible confounding, large estimates of effect, and dose-response relationship.

To rate certainty of evidence from modelling studies, we used the recent guidance developed by the GRADE Working Group (Brozek 2020). As per the guidance, we initially assessed the body of evidence from modelling studies as high certainty and then used the domains described above to assess certainty of model outputs. We then applied the above domains to further downgrade or upgrade certainty of evidence from modelling studies using tailored interpretations as specified in the guidance. For example, risk of bias in modelling studies refers to the credibility of the model and its inputs; inconsistency assesses the difference in the results of two or more models; imprecision examines the model point estimate (e.g. predicted event) and the variability of that estimate; indirectness examines model outputs in relation to the prespecified PICO elements of interest; finally, publication bias refers to the likelihood that relevant models have been developed but not made available (Brozek 2020).

To rate the certainty of evidence from observational studies assessing entry and exit screening measures and quarantine of travellers in detecting infected cases (i.e. diagnostic outcomes, the proportion of cases detected and positive predictive value), we used the GRADE guidance for rating certainty of evidence for diagnostic tests and strategies (Schunemann 2008). In accordance with the guidance, we initially rated the body of evidence from these cross-sectional studies reporting an appropriate reference standard (e.g. a symptom-based screening followed by a PCR testing) as high-certainty evidence. We then applied the five GRADE domains as described above to further downgrade evidence when deemed appropriate.

## RESULTS

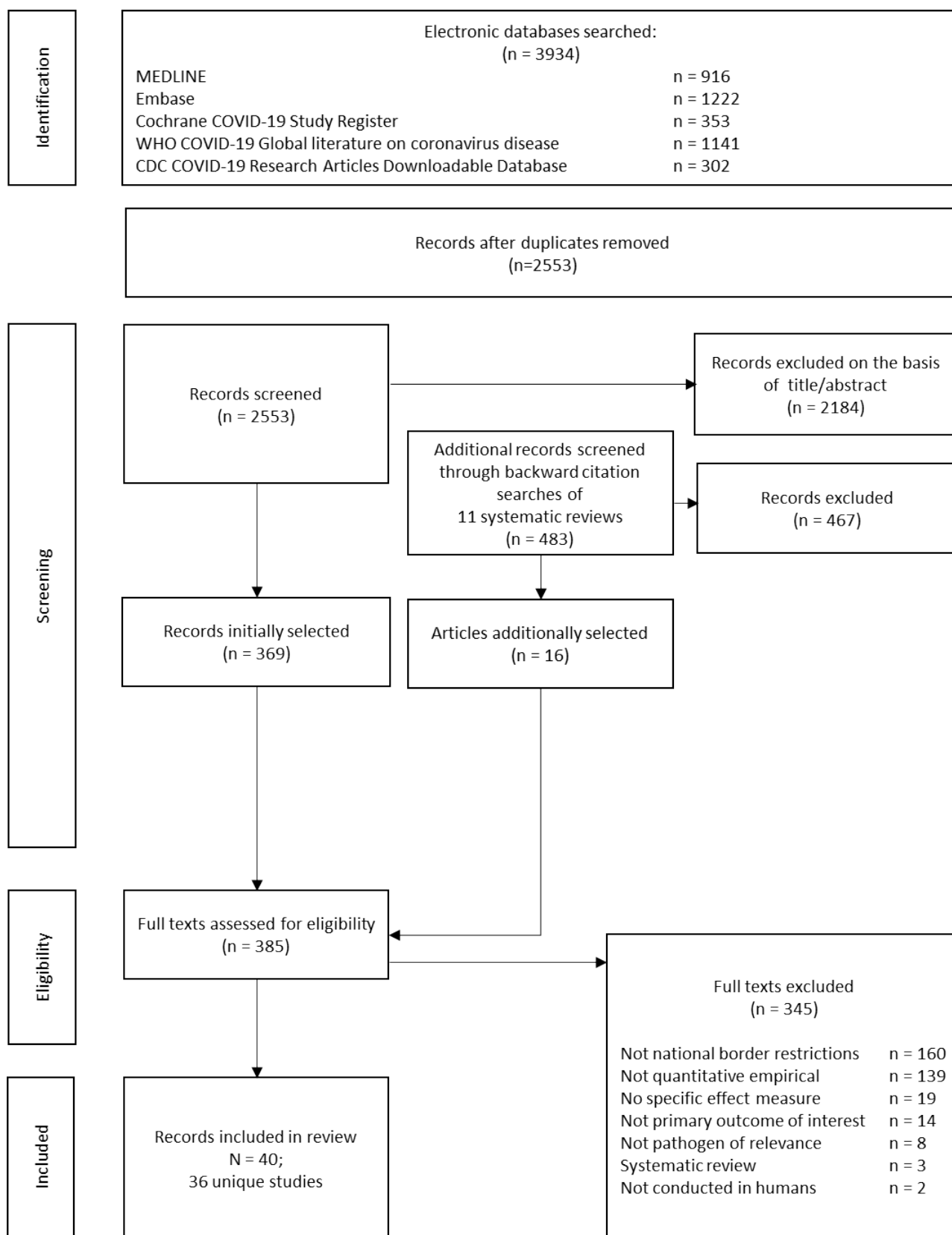
### Results of the search

The PRISMA flow diagram shown in Figure 1 describes the study selection process (Moher 2009). From a total of 3036 unique records screened at the title and abstract screening stage (2553 identified through database searches and 483 through backward citation searches of systematic reviews), we found 385 records to be potentially relevant and screened them at the full-text stage; of these, 40 records met the eligibility criteria and we included

them in the review. These represent 36 unique studies, as four records assessed interventions already addressed by other records (Linka 2020b; Nishiura 2020; Tsuboi 2020; Wang 2007). Reasons for

excluding studies at the full-text screening stage are presented in [Figure 1](#) and further described in the [Characteristics of excluded studies](#).

**Figure 1.**



The characteristics of each of the 36 studies are described in detail in the [Characteristics of included studies](#) and summarised below. Of the 36 included studies, 31 studies were considered as main studies, and five as supporting studies. The latter reported on the number of people who were screened positive without providing the results of confirmation tests, or described no reference testing of those screened negative. This did not allow assessment of the number of cases detected due to the measure (see the primary outcomes above). We contacted four study authors requesting additional information. We did not identify any ongoing studies.

## Included studies

The included studies are described in the following sections according to setting, population, intervention, comparison, outcomes, and study design.

## Setting

We found studies that evaluated, implemented, or simulated travel-related control measures in a range of countries across the globe, representing all WHO regions except for the African and Eastern Mediterranean regions. Countries included Australia ([Adekunle 2020](#); [Costantino 2020](#); [Samaan 2004](#)), Canada ([Anonymous 2004](#); [Gumel 2004](#); [St John 2005](#)), China ([Pang 2003](#); [Wells 2020](#)), Germany ([Goubar 2009](#); [Hoehl 2020](#)), Greece ([Lytras 2020](#)), India ([Mandal 2020](#)), Japan ([Arima 2020](#); [Yamahata 2020](#)), New Zealand ([Wilson 2020](#)), Singapore ([Ng 2020](#); [Wilder-Smith 2003](#)), South Korea ([Boldog 2020](#); [Ryu 2020](#)), Taiwan ([Hsieh 2007](#); [Hsieh 2005](#); [Wang 2007](#)), Thailand ([Boldog 2020](#); [Sriwijitalai 2020a](#)), and USA ([Boldog 2020](#); [Jernigan 2020](#); [Odendaal 2020](#)). Five studies assessed measures implemented across multiple countries using a cross-country comparison ([Anderson 2020](#); [Chinazzi 2020](#); [Koh 2020](#); [Linka 2020a](#); [Utsunomiya 2020](#)), and six modelling studies did not describe a specific country or setting ([Anzai 2020](#); [Clifford 2020](#); [Glass 2006](#); [Gostic 2015](#); [Gostic 2020](#); [Quilty 2020a](#)).

Most studies specified a travel-related control measure that restricted travel from China ([Adekunle 2020](#); [Anzai 2020](#); [Boldog 2020](#); [Chinazzi 2020](#); [Costantino 2020](#); [Hoehl 2020](#); [Jernigan 2020](#); [Mandal 2020](#); [Ng 2020](#); [Odendaal 2020](#); [Ryu 2020](#); [Wells 2020](#)). Other regions restricted by the travel measures included Australia ([Wilson 2020](#)), Hong Kong ([Goubar 2009](#)), Iran ([Adekunle 2020](#)), Italy ([Adekunle 2020](#)), South Korea ([Adekunle 2020](#)), Spain ([Lytras 2020](#)), and the UK ([Lytras 2020](#)).

## Population

Twenty-five of the included studies assessed the impact of a travel-related control measure in relation to COVID-19 ([Adekunle 2020](#); [Anderson 2020](#); [Anzai 2020](#); [Arima 2020](#); [Banholzer 2020](#); [Boldog 2020](#); [Chinazzi 2020](#); [Clifford 2020](#); [Costantino 2020](#); [Gostic 2020](#); [Hoehl 2020](#); [Jernigan 2020](#); [Koh 2020](#); [Linka 2020a](#); [Lytras 2020](#); [Mandal 2020](#); [Ng 2020](#); [Odendaal 2020](#); [Quilty 2020a](#); [Ryu 2020](#); [Sriwijitalai 2020a](#); [Utsunomiya 2020](#); [Wells 2020](#); [Wilson 2020](#); [Yamahata 2020](#)). Ten studies focused on SARS ([Anonymous 2004](#); [Glass 2006](#); [Goubar 2009](#); [Gumel 2004](#); [Hsieh 2005](#); [Hsieh 2007](#); [Pang 2003](#); [Samaan 2004](#); [St John 2005](#); [Wilder-Smith 2003](#)), while one described outcomes for both SARS and MERS ([Gostic 2015](#)).

## Intervention and comparisons

Included studies referred to a range of travel-related control measures, which we classified into four categories.

1. Closure of national borders to entry or exit, or both ([Anderson 2020](#); [Banholzer 2020](#); [Linka 2020a](#); [Linka 2020b](#))
2. Full or partial travel restrictions or bans across national borders ([Adekunle 2020](#); [Anzai 2020](#); [Boldog 2020](#); [Chinazzi 2020](#); [Costantino 2020](#); [Koh 2020](#); [Linka 2020b](#); [Odendaal 2020](#); [Utsunomiya 2020](#); [Wells 2020](#))
3. Entry or exit screening, or both, at national borders or testing ([Anonymous 2004](#); [Arima 2020](#); [Clifford 2020](#); [Glass 2006](#); [Gostic 2020](#); [Gostic 2015](#); [Goubar 2009](#); [Gumel 2004](#); [Hoehl 2020](#); [Jernigan 2020](#); [Lytras 2020](#); [Mandal 2020](#); [Ng 2020](#); [Nishiura 2020](#); [Pang 2003](#); [Quilty 2020a](#); [Samaan 2004](#); [Sriwijitalai 2020a](#); [St John 2005](#); [Tsuboi 2020](#); [Wells 2020](#); [Wilder-Smith 2003](#); [Wilson 2020](#); [Yamahata 2020](#))
4. Quarantine of travellers crossing national borders ([Hsieh 2005](#); [Hsieh 2007](#); [Ryu 2020](#); [Wang 2007](#))

All studies assessing the measures within categories 1 and 2 used models to simulate COVID-19 outbreak scenarios.

The control measures were commonly simulated as a reduction in travel volume (e.g. 25% and 75%; [Adekunle 2020](#); [Anderson 2020](#); [Anzai 2020](#); [Boldog 2020](#); [Chinazzi 2020](#); [Linka 2020a](#)), and any distinction between a complete versus partial border closure would be arbitrary. Thus for data synthesis and the assessment of certainty of evidence, we combined measures in categories 1 and 2 in a broad category of travel restrictions reducing cross-border travel. Importantly, category 3 includes studies assessing entry and exit screening with and without subsequent quarantine; category 4 covers only those studies that assessed quarantine of travellers in the absence of screening measures.

In most modelling studies, the comparison to the travel-related control measure was a scenario in which the measure was not implemented. Many modelling studies, however, described additional scenarios, such as different levels of travel reductions, or combinations of multiple measures (e.g. no intervention versus entry screening versus entry screening with the use of face masks). In the observational studies concerned with screening and travel-related quarantine, the comparison was the counterfactual of not implementing the measure. The observational ecological study assessing the impact of various travel-related control measures, including the early and late implementation of screening, quarantining arrivals from high-risk regions, a ban on arrivals from some regions, and a total closure of borders to international travel, across 142 countries also compared these against the counterfactual of not implementing a measure.

## Outcomes

We included studies assessing three broad categories of primary outcomes:

1. cases avoided due to the measure;
2. number of cases detected due to the measure; and
3. shift in epidemic development.

We identified no studies reporting on any of the secondary outcomes.

For category 1 of primary outcomes, we identified specific outcomes related to the number of imported or exported infected cases ([Adekunle 2020](#); [Anzai 2020](#); [Chinazzi 2020](#); [Costantino 2020](#); [Goubar 2009](#); [Wells 2020](#)), the number of additional cases seeded by

arriving infections (Hsieh 2007; Ryu 2020), the number (proportion) of the infected cases (Anderson 2020; Banholzer 2020; Costantino 2020; Linka 2020a), and the number of deaths due to the disease (Costantino 2020; Gumel 2004; Hsieh 2007).

For category 2 of primary outcomes, we identified outcomes related to the number (proportion) of infected travellers detected (Glass 2006; Gostic 2020; Gostic 2015; Quilty 2020a; Wells 2020), and data enabling assessment of the proportion of cases detected and positive predictive value of entry and exit screening and subsequent measures (Arima 2020; Hoehl 2020; Jernigan 2020; Lytras 2020; Ng 2020; Samaan 2004; Yamahata 2020).

Finally, for category 3 of primary outcomes, we identified outcomes related to the change in the effective reproduction number (Koh 2020), change in the epidemic growth acceleration (Utsunomiya 2020), time to an outbreak (Anzai 2020; Clifford 2020; Mandal 2020; Odendaal 2020; Wilson 2020), and risk of an outbreak (Anzai 2020; Boldog 2020).

### Study designs

We identified 22 modelling studies (Adekunle 2020; Anderson 2020; Anzai 2020; Banholzer 2020; Boldog 2020; Chinazzi 2020; Clifford 2020; Costantino 2020; Glass 2006; Gostic 2015; Gostic 2020; Goubar 2009; Gumel 2004; Hsieh 2007; Linka 2020a; Mandal 2020; Odendaal 2020; Quilty 2020a; Ryu 2020; Utsunomiya 2020; Wells 2020; Wilson 2020); of these 17 addressed COVID-19 (Adekunle 2020; Anderson 2020; Anzai 2020; Banholzer 2020; Boldog 2020; Chinazzi 2020; Clifford 2020; Costantino 2020; Gostic 2020; Linka 2020a; Mandal 2020; Odendaal 2020; Quilty 2020a; Ryu 2020; Utsunomiya 2020; Wells 2020; Wilson 2020), four were concerned with SARS (Glass 2006; Goubar 2009; Gumel 2004; Hsieh 2007), and one addressed both SARS and MERS (Gostic 2015). Modelling studies varied in the employed modelling approaches, with details presented in the [Characteristics of included studies](#)

Thirteen studies were observational studies reporting on entry and exit screening with or without a parallel or subsequent quarantine of travellers (Anonymous 2004; Arima 2020; Hoehl 2020; Hsieh 2005; Jernigan 2020; Lytras 2020; Ng 2020; Pang 2003; Samaan 2004; Sriwijitalai 2020a; St John 2005; Wilder-Smith 2003; Yamahata 2020). Of these, seven studies focused on COVID-19 (Arima 2020; Hoehl 2020; Jernigan 2020; Lytras 2020; Ng 2020; Sriwijitalai 2020a; Yamahata 2020), and six studies assessed these measures in the context of SARS (Anonymous 2004; Hsieh 2005; Pang 2003; Samaan 2004; St John 2005; Wilder-Smith 2003). Of these 13 studies, we classified five studies (one focusing on COVID-19 and four on SARS) as supporting studies, as they did not provide an appropriate reference standard to enable an assessment of the proportion of cases detected or positive predictive value, or both, of the screening measures (Anonymous 2004; Pang 2003; Sriwijitalai 2020a; St John 2005; Wilder-Smith 2003). Of the seven studies that assessed entry and exit screening in the context of COVID-19, six used a cross-sectional design with follow-up reference testing (Arima 2020; Hoehl 2020; Jernigan 2020; Lytras 2020; Ng 2020; Yamahata 2020).

An additional observational ecological study reported on an ecological regression model to estimate the impact of different travel-related control measures in containing COVID-19 (Koh 2020).

Of the identified and included records, five were published only as preprints and thus were not peer-reviewed (Anderson 2020; Banholzer 2020; Koh 2020; Odendaal 2020; Wilson 2020).

### Risk of bias and quality of included studies

The risk of bias (observational studies) and quality (modelling studies) is summarised in [Table 1](#), [Table 2](#) and [Table 3](#); these summaries are stratified by intervention type and disease, consistent with the narrative synthesis.

We assessed risk of bias of observational studies concerned with screening or quarantining travellers using QUADAS-2. [Table 1](#) shows that the domains related to the population selection and index test (D1 and D2) were generally associated with low risk of bias, while the domains related to the reference test and the flow (D3 and D4) were generally associated with a higher risk of bias. The reference test approach varied between studies, and included symptom observation during a 14-day quarantine period, a PCR test of those who developed symptoms and a single PCR test or two PCR tests of all travellers. Depending on the reference test approach, there is a risk of firstly, not identifying asymptomatic COVID-19 infections, secondly, missing cases with an incubation period longer than the 14 days of quarantine, and thirdly, having a false negative PCR test by chance or due to the wrong timing of testing during the course of infection (Kucirka 2020). These would lead to an overestimation of the proportion of cases detected and positive predictive value. Individual judgements for each study can be found in [Appendix 7](#).

Furthermore, the QUADAS-2 tool facilitates an assessment of the applicability of the studies; overall we had substantial concerns regarding the applicability of these studies, as each was conducted in a very specific situation, that is, taking place on evacuation flights or during a cruise ship outbreak. Thus it is unclear how applicable the findings regarding these specific populations and screening programmes would be to more generic entry and exit screening measures aiming to screen larger numbers of individuals over an extended period of time.

We assessed the risk of bias of the one included observational ecological study using ROBINS-I; it should be noted that although the tool was not developed specifically for this type of study, we considered it reasonably appropriate for capturing risk of bias concerns. [Table 2](#) shows the ratings for all domains; we rated the overall risk of bias for this study as serious. The risk of bias for this study was rated as high; concerns related to confounding, deviations from the intended intervention and the measurement of outcomes. Individual judgements for this study can be found in [Appendix 8](#).

We appraised the quality of modelling studies using the above described bespoke tool. Ratings for each study are found in [Table 3](#). Studies varied widely with regards to quality, although some patterns emerged. For example in several studies, there were concerns regarding the appropriateness of structural assumptions and input parameters (Q2 and Q4), as well as regarding an inadequate assessment of uncertainty (Q9). In several studies, there were concerns regarding the appropriateness of structural assumptions and input parameters (Q2 and Q4), as well as regarding an inadequate assessment of uncertainty (Q9). A major concern with the structural assumptions of a model could involve, for example, where a study treats travel restrictions implemented in multiple countries at different times as independent of time,

place and context. Input parameters could be a major concern when a study assumed the sensitivity of an entry screening measure to be over 80%, when most empirical results suggest that the value is much lower. Major concerns with the assessment of uncertainty occurred when, for example, studies provided no assessment of whether altering the assumptions of the model influenced the results. Additionally, the majority of studies did not conduct an internal validation of their models (Q5-Q8), although we did not consider this a critical flaw that would lead to 'major concerns'. Importantly, many studies did not undertake any external validation (i.e. a validation on any collected data), which we considered important with respect to the directness of the findings (see Assessment of the certainty of evidence). Individual judgements for each study can be found in [Appendix 9](#).

## Effects of interventions/results of the synthesis

In the following, we provide a detailed narrative summary of the impact of three broad categories of travel-related control measures.

1. Travel restrictions reducing cross-border travel (based on evidence from modelling studies and one observational ecological study)
2. Entry and exit screening at national borders with or without quarantine of travellers (includes evidence from modelling studies and observational studies)
3. Quarantine of travellers only (includes evidence from modelling studies and observational studies)

We first present the evidence for COVID-19 for specific outcomes in each of the three outcome categories, including cases avoided due to the measure, cases detected due to the measure, and shift in epidemic development due to the measure; we then present the evidence for SARS and MERS.

### 1. Travel restrictions reducing cross-border travel

#### 1.1 COVID-19

Overall, we identified 11 modelling studies and one observational ecological study contributing evidence to this category of travel-related control measures for different primary outcomes ([Adekunle 2020](#); [Anderson 2020](#); [Anzai 2020](#); [Banholzer 2020](#); [Boldog 2020](#); [Chinazzi 2020](#); [Costantino 2020](#); [Koh 2020](#); [Linka 2020a](#); [Odendaal 2020](#); [Utsunomiya 2020](#); [Wells 2020](#)). Five studies reported on the number of imported or exported cases ([Adekunle 2020](#); [Anzai 2020](#); [Chinazzi 2020](#); [Costantino 2020](#); [Wells 2020](#)), four studies on the number of (new) cases ([Anderson 2020](#); [Banholzer 2020](#); [Costantino 2020](#); [Linka 2020a](#)), one study on the number of deaths ([Costantino 2020](#)), two studies on the time to outbreak ([Anzai 2020](#); [Odendaal 2020](#)), two studies on the risk of an outbreak ([Anzai 2020](#); [Boldog 2020](#)), 2 studies on the effective reproduction number ([Koh 2020](#); [Linka 2020a](#)), and one study on the epidemic growth acceleration after intervention implementation ([Utsunomiya 2020](#)). [Table 4](#) presents the GRADE evidence profile for this body of evidence. While we observed a consistent, positive direction of effect, we assessed the certainty of evidence for all of these outcomes as 'low' or 'very low' because of risk of bias (quality), indirectness, and imprecision in the bodies of evidence.

#### 1.1.1. Outcome category: cases avoided due to the measure

##### Number of imported and exported cases

Five studies reported on the number of imported or exported cases. All of these showed reductions in the number of cases, with numbers varying between countries and with the timing of implementation, as well as severity of the implemented measure and levels of community transmission.

[Adekunle 2020](#), a global meta-population SEIR modelling study with no major quality concerns, modelled the impact of the Wuhan lockdown on the number of cases imported to Australia, as well as the impact of travel restrictions from China, Iran, South Korea and Italy. The study found that the Wuhan lockdown and a travel ban from China led to 55 fewer cases imported from China to Australia; however, the additional travel bans imposed on Iran, South Korea and Iran did not lead to any significant reductions in the number of imported cases.

Similarly, [Chinazzi 2020](#), an individual-based, stochastic, spatial meta-population epidemic modelling study with no major quality concerns, observed an initial large reduction of cases exported from China to other countries (between 23 January and 5 February 2020); however, by 1 March 2020 the number of cases are shown to rebound. Authors note that if the community transmission within a country were reduced (e.g. if the current reproduction number ( $R(T)$ ) is brought below 1), then the restrictions would be more effective in both delaying the epidemic activity in the country and reducing the number of imported cases.

[Costantino 2020](#), an age-specific, deterministic modelling study with major quality concerns related to the model's structural assumptions, found that a travel ban led to over 100 fewer cases imported from China to Australia, however, most of the additional cases were avoided during the first six weeks of the epidemic (80% reduction). Partial relaxation of the ban led to only slightly fewer imported cases than full relaxation.

[Wells 2020](#), a modelling study using a custom model based on maximum likelihood methods with no major quality concerns, found that the lockdown of Wuhan and the rest of Hubei Province led to 549 cases not being exported from China to other countries (81% reduction).

Similarly, [Anzai 2020](#), a counterfactual projection modelling study based on a Poisson process with major quality concerns related to the model's structural assumptions and input parameters, found various travel restrictions from China to lead to 226 (95% confidence interval (CI) 86 to 449) cases not being exported from China to other countries (70% reduction).

##### Number or proportion of (new) cases

Four studies reported on the number of (new) cases. All of these showed reductions in the number of cases, with numbers varying in relation to the extent of existing community transition and contact rate.

[Anderson 2020](#), a complex Bayesian SEIR modelling study with no major quality concerns, found that the number of additional cases after relaxation of the border closures varied between regions and based on the contact rate. The number of additional cases after six weeks seeded by one pre-symptomatic infectious traveller per week was higher for regions where substantial community

transmission was still occurring (e.g. California: 25 to 100, Sweden: 20 to 80), and lower for regions where less transmission was occurring (e.g. Japan: 1 to 5, New Zealand: 5 to 10). Additionally, a lower contact rate, a general measure of the amount of social contacts among a population, led to a substantially lower number of additional cases in all regions.

[Banholzer 2020](#), a Bayesian hierarchical modelling study with major quality concerns related to the model's structural assumptions, assessed the impact of border closures across 12 countries. It found that border closures led to a 26% reduction in new cases (95% CI 13% to 37%). Study authors write that these results should be interpreted with caution due to the difficulty of disentangling the specific effects of various measures, and because of the critical role that the timing of the introduction of measures (which they did not assess) may play.

[Costantino 2020](#), an age-specific, deterministic modelling study with major quality concerns related to the model's structural assumptions, found that a full ban on international travel from China followed by full relaxation led to a large reduction in the total number of cases in Australia (fewer than 300 cases compared to 3000 cases without the ban).

[Linka 2020a](#), a compartmental SEIR modelling study using a cross-country comparison and with major quality concerns related to the lack of uncertainty assessment, found that the introduction of the travel restrictions across almost all European Union (EU) countries led to a decrease in the proportion of infectious individuals in the population.

#### Number of deaths

[Costantino 2020](#) an age-specific, deterministic modelling study with major quality concerns related to the model's structural assumptions, found that a full ban on international travel from China followed by full relaxation led to a large reduction in the total number of deaths in Australia (8 deaths compared to 400 deaths without the travel ban).

### 1.1.2 Outcome category: shift in epidemic development

#### Time to outbreak

Two studies reported on the time to outbreak, with much variation in the number of days by which the intervention may delay the outbreak, and implicating a role for the basic reproduction number in the country.

[Odendaal 2020](#) is a model using observed data to fit an exponential curve and project the cumulative number of infected cases into the future. We had major quality concerns related to the model's structural assumptions and the lack of uncertainty assessment. This study reports an early implementation of a travel ban on China to delay community transmission in the USA by 26 days.

[Anzai 2020](#), a counterfactual projection modelling study based on a Poisson process with major quality concerns related to the model's structural assumptions and input parameters, found that various restrictions of travel from China to other countries were associated with a delay in time of a major epidemic. With a basic reproduction number ( $R_0$ ) of 2.2 and 3.7, the delay was less than one day, with an  $R_0$  of 1.5, it was 1.25 to 2.4 days.

#### Risk of outbreak

Two studies reported on the risk of an outbreak, suggesting that the basic reproduction number, the number of cases in the country of arrival and the percentage of contacts being traced contribute to the substantial variation in the risk of an outbreak taking place.

As with time to outbreak, [Anzai 2020](#) found that risk reduction associated with various travel restrictions from China differed with variations in  $R_0$  and the proportion of contacts traced: the largest risk reduction was 37% with  $R_0$  being 1.5 and 50% of contacts being traced. The smallest reduction was 1% with  $R_0$  being 3.7 and 10% of contacts traced.

[Boldog 2020](#), a time-dependent SEIR modelling study with no major quality concerns, assessed the impact of varying degrees of travel restrictions in China on the USA, Canada, Thailand and South Korea, and found that the impact varied depending on  $R$  in the country protected by the measure and the number of cases in China. For Thailand and South Korea, restrictions could be effective in preventing an outbreak when the local  $R$  is low (e.g. 1.1); when the local  $R$  is higher (e.g. 2.2) or when the number of cases in China increases (e.g. 600,000 cumulative cases), a beneficial impact of restrictions becomes increasingly unlikely. For the USA, even at lower numbers of cases in China (150,000), 25%, 50% and 75% travel restrictions are associated with a risk of a major outbreak of 80%, 65% and 45%, respectively. At higher numbers of cases in China (400,000), 25% and 50% restrictions had no impact, while 75% restrictions were associated with a risk of a major outbreak of approximately 85%. For Canada, at lower numbers of cases in China, 25%, 50% and 75% travel restrictions yielded a risk of a major outbreak of 35%, 30% and 15%, respectively; at higher numbers of cases in China these risks were 80%, 70% and 45%, respectively.

#### Effective reproduction number

Two studies reported on changes in the effective reproduction number, suggesting that travel restrictions may contribute to improvements in the effective reproduction number.

[Koh 2020](#), an observational ecological study with serious risk of bias related to confounding, deviations from the intended intervention and the measurement of outcomes, assessed the impact of various travel-related control measures. In general, more stringent measures and earlier implementation were more effective; early and late implementation of total border closures showed the strongest and statistically significant associations. Associations for all other measures were smaller in magnitude and not statistically significant.

[Linka 2020a](#), a compartmental SEIR modelling study using a cross-country comparison and with major quality concerns related to the lack of uncertainty assessment, found that after the implementation of the travel restrictions in the EU, countries saw an inflection point in  $R(T)$ ; the duration of time until this inflection point varied, with a mean of 12.6 days.

#### Epidemic growth acceleration

[Utsunomiya 2020](#), a Moving Regression and Hidden Markov modelling study with major quality concerns associated with the assessment of model uncertainty, found that international travel controls across 62 countries were associated with a significant decrease in the growth acceleration of the epidemic progression ( $-6.05\%$  change;  $P = 2.31 \times 10^{-5}$ ).

## 1.2. SARS/MERS

We did not identify any study assessing this category of measures for SARS or MERS.

## 2. Entry and exit screening at national borders with or without quarantine of travellers

### 2.1. COVID-19

Overall, we identified six modelling studies contributing evidence to entry and exit screening at national borders (Clifford 2020; Gostic 2020; Mandal 2020; Quilty 2020a; Wells 2020; Wilson 2020). All of these studies simulated the impact of entry and exit screening alone without considering a parallel or subsequent quarantine of travellers. Wilson 2020 reports on different scenarios of simulating a range of control measures, including the addition of quarantine of travellers to entry and exit screening.

In addition, we identified six observational studies contributing evidence to entry and exit screening at national borders (Arima 2020; Hoehl 2020; Jernigan 2020; Lytras 2020; Ng 2020; Yamahata 2020), all conducted in very specific settings: five were undertaken in the context of evacuation flights and one during a cruise ship outbreak. Despite differences, the structure and sequence of events were relatively similar across studies. A first stage involved symptom screening of all individuals in the study either at departure or upon arrival or both. In a second stage, after arrival, all or most individuals were quarantined, observed and tested using different procedures, over a period of at least 14 days. Of the observational studies all six studies provide information on a symptom-based exit or entry screening, one study on symptom- and exposure-based entry and exit screening (Hoehl 2020), one on symptom-based departure screening (Jernigan 2020), two on symptom-based entry screening (Arima 2020; Lytras 2020), one on fever-based entry screening (Ng 2020), and one on symptom- and exposure-based entry screening (Yamahata 2020).

Three modelling studies reported on the time to outbreak (Clifford 2020; Mandal 2020; Wilson 2020), and three modelling studies on the detection of infected travellers (Gostic 2020; Quilty 2020a; Wells 2020). The six observational studies reported data to enable an assessment of the proportion of cases detected and the positive predictive value of the screening measures (Arima 2020; Hoehl 2020; Jernigan 2020; Lytras 2020; Ng 2020; Yamahata 2020). Table 5 presents the GRADE evidence profile for this body of evidence. We assessed the certainty of evidence for all of these outcomes as low or very low. We downgraded the body of evidence from modelling studies for risk of bias (quality), indirectness, and inconsistency. We downgraded the body of evidence from observational studies for risk of bias and indirectness.

#### 2.1.1. Outcome category: shift in epidemic development

##### Time to outbreak

Three modelling studies reported on time to an outbreak, with the modelled number of days by which an outbreak can be delayed varying widely. The timing of implementation and the number of asymptomatic individuals screened appear to play a role, as does the combination of entry and exit screening with other travel-related measures.

Clifford 2020, a stochastic modelling study based on a Poisson process with major quality concerns related to model input

parameters, reports that entry and exit screening, alone or combined, and sensitisation to increase awareness and encourage appropriate responses can delay an outbreak in a hypothetical population. Assuming a baseline sensitivity of 86%, at the beginning of the outbreak when very few infected individuals arrive, the measures can delay the outbreak by several days (ranging from 1 to 8 days). If introduced later, when the number of infected individuals arriving is higher, the measures do little to delay the outbreak (ranging from under 1 to 1 day).

Mandal 2020, a deterministic SEIR modelling study with major quality concerns due to the model structural assumptions and input parameters, found that entry screening of symptomatic individuals led to a marginal delay in reaching 1000 cases (2.2-day delay, from 45 to 47.7 days) in a hypothetical population. The study authors calculate that at least 75% of asymptomatic individuals would need to be screened in order to delay the epidemic significantly.

Finally, Wilson 2020, a stochastic SEIR modelling study with major quality concerns related to the model's structural assumptions, input parameters, and lack of uncertainty assessment, found that screening of travellers arriving from a hypothetical, low-prevalence area (modelled on Australia), combined with other measures, delayed an outbreak in a hypothetical disease-free area (modelled on New Zealand). Under the assumption of one flight per day (7.1% of normal travel volume), exit screening alone, assuming a 50% sensitivity, delayed an outbreak by 0.5 years, from 1.7 years (0.04 to 6.09) to 2.2 years (0.6 to 8.11). Co-interventions, such as entry screening, quarantine, testing of arriving travellers, in-flight wearing of masks, contact tracing and self-reporting of symptoms led to larger delays of the outbreak. The most effective combination of measures was exit screening, in-flight wearing of masks, entry screening and a 14-day quarantine of all arriving travellers, leading to a 32.4-year delay, to 34.1 years (0.86 to 126).

#### 2.1.2. Outcome category: cases detected due to the measure

##### Detection of infected travellers

Three modelling studies reported on the number or percentage of infected travellers detected, with the percentage of asymptomatic cases and the combination of entry and exit screening with other travel-related measures implicated in the observed heterogeneity.

Gostic 2020, a probabilistic modelling study with no major quality concerns, reports on the effectiveness of combined entry and exit screening based on thermal scanners detecting fever and self-reporting of exposure in a hypothetical population with varying percentages of subclinical (i.e. asymptomatic and thus potentially undetectable) cases. With 25% of cases assumed to be subclinical, combined entry and exit screening would detect 27% (95% CI 10% to 47%) of infected cases. On their own, exit and entry screening would detect 17% (95% CI 3% to 33%) and 20% (95% CI 7% to 40%), respectively. As the proportion of subclinical cases increases (worst-case scenario) the proportion of detected cases decreases, while as the subclinical proportion decreases (best-case), the proportion of cases detected increases.

Quilty 2020a, a microsimulation modelling study with major quality concerns related to the model's input parameters and the lack of uncertainty assessment, assumed a sensitivity of 86% for entry and exit screening, and 17% of cases as undetectable. They found that thermal scanner-based entry and exit screening, as well as entry

screening alone, detected 53% (95% CI 35% to 72%) of cases in a hypothetical population; exit screening was comparatively less effective, detecting only 44% (95% CI 33% to 56%) of cases.

Finally, Wells 2020, a modelling study using a custom model based on maximum likelihood methods with no major quality concerns, estimated that, assuming only the 35.7% of symptomatic individuals are detected, 82 cases (72 to 95) cases exported from China were contained by general screening measures put in place across the world.

#### Proportion of cases detected and positive predictive value

Six observational studies reported on the proportion of cases detected and the positive predictive value associated with entry and exit screening of travellers, and all of these subsequently quarantined all travellers, independently of whether these were screened positive or negative (Arima 2020; Hoehl 2020; Jernigan 2020; Lytras 2020; Ng 2020; Yamahata 2020). The screening procedures, approaches to identify cases and study data for each of these studies are summarised in Table 6. The proportion of cases detected varied widely, and the positive predictive value was generally low, even where the prevalence of SARS-CoV-2-infected travellers was relatively high.

Arima 2020 involved repatriation of a group of 566 individuals from Hubei, China to Japan between 29 and 31 January 2020. All individuals were screened on arrival based, firstly, on temperature screening before disembarkation, secondly, face-to-face interviews eliciting information on symptoms including fever, cough and other non-specific symptoms consistent with COVID-19, and thirdly, a PCR test of oropharyngeal swab samples. All 566 individuals were quarantined for 14 days, independent of the results of the screening and those developing symptoms received a PCR test. At the end of the quarantine period, all passengers were tested again with a follow-up PCR test. There were 12 cases among the 552 returnees with complete follow-up (prevalence: 2.2%).

- Symptom-based entry screening: during the symptom-based screening, 63 individuals were screened positive (i.e. being symptomatic), and four of these were cases (i.e. confirmed either through a PCR test upon arrival or through a follow-up PCR test; proportion of cases detected: 33%, positive predictive value: 6.4%).
- PCR-based entry screening: the PCR screening upon arrival identified seven cases; five additional cases who initially tested negative were identified through a follow-up PCR test (proportion of cases detected through the initial PCR test: 42%; as a case was defined by having a positive PCR test result either in the initial or in the follow-up PCR no positive predictive value can be calculated).
- Symptom- and PCR-based entry screening: through the combination of the initial symptom-based screening and the initial PCR test, 68 screened positive (2 in both the symptom-based screening and the initial PCR test, 61 in the symptom-based screening only, and 5 based on the initial PCR test only). Among these 68 individuals there were nine cases. Three further cases were identified through a follow-up PCR test, but were missed both by the initial symptom-based screening and the initial PCR test (proportion of cases detected: 75%; positive predictive value: 10%).
- Symptom-based observation during quarantine: of the 503 out of 566 individuals who were asymptomatic at entry screening,

six individuals developed symptoms during quarantine. Of these, two had tested positive in the initial PCR test, two had tested negative in the initial PCR test but positive in a follow-up PCR test, and two tested negative in both the initial and the follow-up PCR test. One individual tested positive in a follow-up PCR test at the end of the quarantine period, but had remained asymptomatic throughout the quarantine. Thus, the combination of symptom-based entry screening and quarantine observation identified 11 out of 12 cases (proportion of cases detected: 91%, positive predictive value: 16%).

Hoehl 2020 involved evacuating a group of 126 individuals from Hubei, China to Frankfurt, Germany on 1 February 2020. All individuals were screened before flight departure and upon arrival based on firstly, the presence of symptoms, secondly, contact with an infected person and thirdly, accompanying a person belonging to one of the two other groups; all 126 individuals were quarantined for 14 days, independent of the results of the screening. There were two cases among the 126 individuals (prevalence: 1.6%), who were detected by PCR testing performed on all individuals.

- Entry and exit screening: during the pre-departure screening stage, 10 individuals were screened positive and during the arrival screening one additional individual was screened positive, but none of these were cases (proportion of cases detected: 0%, positive predictive value: 0%).
- Symptom-based observation during quarantine: during the quarantine period, six passengers developed symptoms, all of whom tested negative in the PCR test. While all cases in this study were identified by the PCR test, one of the cases developed symptoms during hospital quarantine, and therefore would have developed symptoms within the 14-day quarantine period. The combination of symptom-based arrival screening and symptom observation during quarantine would have detected one case, would have missed one, and would have falsely identified 17 individuals as positive (proportion of cases detected: 50%; positive predictive value: 5.6%)

Jernigan 2020 assessed the evacuation of 808 US citizens on five flights from Hubei, China to the USA between 29 January and 6 February 2020. All individuals were screened upon departure based on the presence of symptoms, including fever, cough and shortness of breath; all individuals were subsequently quarantined for 14 days in governmental facilities. Overall, three cases among the 808 individuals were identified (prevalence: 0.4%) although the true number of cases was likely higher, as only symptomatic individuals were tested.

- Exit screening: during exit screening, no individuals were screened positive (proportion of cases detected: 0%; positive predictive value: not calculable).
- Symptom-based observation during quarantine: during subsequent quarantine and observation, 28 people developed COVID-19-related symptoms and were tested; in three of these COVID-19 was confirmed. We could not calculate the proportion of cases detected or the positive predictive value, as only those with symptoms received the reference test.

Lytras 2020 studied the repatriation of 783 individuals from London, UK, Madrid, Spain and Istanbul, Turkey to Athens, Greece between 20 and 25 March 2020. All individuals were screened upon arrival based on the presence of symptoms, and one symptomatic

individual was identified. Subsequently, all passengers were quarantined either in a hotel or at home for 14 days. All passengers received a PCR test on the day of arrival, which showed that there were 40 cases among the 783 individuals (prevalence: 5.1%).

- Entry screening: upon entry screening, one individual was screened positive, and this individual was also a case (proportion of cases detected: 2.5%; positive predictive value: 100%).
- Symptom-based observation during quarantine: during the subsequent 14-day self-quarantine, 40 individuals developed symptoms (in addition to the 1 individual who was already symptomatic upon arrival), of whom four had a positive PCR test result upon arrival. It is unclear how many of the 36 PCR-negative individuals who developed symptoms were cases, as they did not receive an additional PCR test. Symptom-based observation during the quarantine period would have detected at least four additional cases, possibly more. As there were no additional tests beyond the initial PCR test, we could not calculate the proportion of cases detected or the positive predictive value.

Ng 2020 involved the evacuation of 97 individuals from Wuhan, China to Singapore on 31 January 2020. All individuals were screened for fever (defined as 38 °C or higher) upon departure with three febrile individuals being denied boarding (their status is not known). The remaining 94 individuals were screened for fever upon arrival and were quarantined in a government quarantine facility. There were four cases among the 94 individuals (prevalence: 4.3%).

- Entry screening: entry screening identified two individuals as high-risk, both of whom turned out to be cases (proportion of cases detected: 50%; positive predictive value: 100%).
- Symptom-based observation during quarantine: during the 14-day quarantine following the arrival screening, two additional cases were detected by a PCR test. It is, however, not described if they developed symptoms and would have been detected based on symptom observation during the quarantine period or not.

Yamahata 2020 and Tsuboi 2020 examined the situation aboard the Diamond Princess cruise ship in the port of Yokohama, Japan beginning on 3 February 2020. Quarantine officers conducted a health evaluation (not further specified) of all 3771 passengers and crew members between 3 and 5 February 2020. On 5 February 2020, all 2666 passengers were quarantined for 14 days in their cabins, while the crew was quarantined on board, continuing to maintain ship functions and support passengers. Those reporting symptoms received a PCR test, with a subsequent evaluation of all passenger and crew over the period of quarantine until 23 February 2020. After having had at least one negative PCR test and being symptom-free for 14 days under quarantine observation, 2666 passengers were allowed to disembark. The 1045 crew members were allowed to disembark the ship on 23 February 2020, after having received a negative PCR exit test. Overall, there were 696 cases among the passengers and crew (prevalence: 18.8%). As some passengers and crew may have caught COVID-19 during the quarantine period, the prevalence at the time of arrival of the ship in the port may have been lower.

- Exit and entry screening: during the initial health evaluation 31 individuals were screened positive based on having fever or respiratory symptoms, or being a close contact of a symptomatic individual. These included 10 true cases (proportion of cases

detected: 1.4%; positive predictive value: 32.3%). Under the assumption that the number of cases was stable during the quarantine period (i.e. that no additional infections occurred after the arrival of the ship in the port and the beginning of quarantine) proportion of cases detected was 1.4%.

- Observation during quarantine: of those 696 individuals with a positive PCR test, 410 were asymptomatic (i.e. without fever or respiratory symptoms) at the time of testing. It is not reported how many among them developed symptoms within the observation period. A total of 403 individuals on the ship were found to be febrile, of whom 223 were diagnosed with a PCR test as COVID-19 cases, which includes the febrile cases identified in the initial screening. The proportion of cases detected and positive predictive value of the quarantine observation cannot be calculated as it is not reported how many of those who were asymptomatic when they received their positive PCR test developed symptoms during the quarantine observation period.

## 2.2. SARS

We identified four modelling studies (Glass 2006; Gostic 2015; Goubar 2009; Gumel 2004), and one observational study (Samaan 2004), contributing evidence to entry and exit screening at national borders in the context of SARS. All of the studies assessed or simulated the impact of entry and exit screening alone without considering a follow-up quarantine of travellers. One modelling study reports on the number of imported cases (Goubar 2009), one study on the number of deaths (Gumel 2004), and two studies on the detection of infected travellers (Glass 2006; Gostic 2015). The one observational study provided sufficient information to enable the assessment of diagnostic outcomes, including the proportion of cases detected and positive predictive value. Table 5 presents the GRADE evidence profile for this body of evidence. We assessed certainty of evidence for these outcomes as low or very low. We downgraded the body of evidence from modelling studies because of evidence indirectness and imprecision. For the observational study, we were concerned with risk of bias, indirectness, and imprecision.

### 2.2.1. Outcome category: cases avoided due to the measure

#### Number of imported cases

Goubar 2009, a modelling study using a non-homogeneous Poisson process with no major quality concerns, assessed the number of imported cases from Beijing, China to Frankfurt, Germany. Symptom-based screening, regardless of its hypothetical sensitivity, predicted no reduction in the number of imported cases (ranging from 0.006 to 0.8 total cases) compared to the number of cases imported in the absence of screening. Similarly, symptom-based screening, regardless of its hypothetical sensitivity, predicted no reduction in the number of imported cases from Hong Kong to Singapore (ranging from 0.45 to 2.7 total cases) compared to the number of cases imported in the absence of screening (ranging from 0.51 to 2.7 total cases).

#### Number of deaths

Gumel 2004, a deterministic SEIR model with no major quality concerns, compared a hypothetical perfect thermal scanner-based entry screening programme from the beginning of the SARS outbreak in Toronto to no screening programme. They found that screening, when one symptomatic and six asymptomatic cases had

already been introduced into the community, would have led to only a slight reduction in total deaths from 38 to 35 over 200 days, compared to no screening programme.

## 2.2.2. Outcome category: cases detected due to the measure

### Detection of infected travellers

Two modelling studies reported on the proportion or number of infected travellers detected. The effectiveness of the assessed measures varies greatly with the sensitivity of the screening test, the level of awareness and contact tracing in place in the region of departure, and the overall stage of the epidemic.

[Glass 2006](#), a transmission modelling study with no major quality concerns, found border screening with a low sensitivity (13.8%) to detect only 10% (95% CI 3% to 23%) of infected travellers in a hypothetical population. With increasing sensitivity, the proportion of infected travellers detected also increases.

[Gostic 2015](#), a probabilistic modelling study with no major quality concerns, assessed application of different screening approaches based on fever or risk profile in a hypothetical population during entry and exit of travellers. Combined fever and risk screening or fever screening alone both at exit and entry in a stable epidemic were the most effective, detecting 63% (95% CI 48% to 75%) of cases. Risk screening at entry in a growing epidemic was the least effective, detecting 19% (95% CI 10% to 28%) of cases. In general, entry screening alone was less effective than entry and exit screening, risk and fever screening was more effective than each individually, and screening was more effective in a stable epidemic compared to a growing epidemic.

### Proportion of cases detected and positive predictive value

[Samaan 2004](#), an observational study with serious risk of bias, examined a multi-level entry screening programme of 1.84 million arrivals to Australia between 5 April and 16 June 2003. Of these arrivals, 13.1% were from countries with local SARS transmission. Of these, 794 individuals were referred to the second stage of the multi-level screening, based on symptoms, travel history and the application of the WHO probable case definition; this resulted in the positive screening of four individuals meeting the WHO case definition with an additional two being placed under home surveillance. None of the four individuals screened positive were confirmed to have SARS. There were 13 probable SARS cases, (of whom five were symptomatic on arrival in Australia) among the 1.84 million travellers (prevalence: < 0.001%), who were missed by airport screening despite being symptomatic on arrival, resulting in a proportion of cases detected of 0% and a positive predictive value of 0%.

## 2.3. MERS

We identified one modelling study contributing evidence to entry and exit screening at national borders in the context of MERS ([Gostic 2015](#)). The study reported on the detection of infected travellers. [Table 5](#) presents the GRADE evidence profile for this body of evidence. We assessed it as very low certainty because of indirectness and imprecision.

## 2.3.1. Outcome category: cases detected due to the measure

### Detection of infected travellers

[Gostic 2015](#), a probabilistic modelling study with no major quality concerns, assessed different screening approaches (i.e. based on fever or risk profile) both during the exit and entry of travellers in a hypothetical population. It found combined fever and risk screening or fever screening alone both at exit and entry in a stable epidemic to be the most effective, detecting 45% (95% CI 31% to 62%) of cases.

### Supporting studies for entry and exit screening at national borders

We identified six supporting studies in this category of travel-related control measures, two concerned with COVID-19 ([Jernigan 2020](#); [Sriwijitalai 2020a](#)) and four addressing SARS ([Anonymous 2004](#); [Pang 2003](#); [St John 2005](#); [Wilder-Smith 2003](#)). [Jernigan 2020](#) also contributes data as a main study, thus, although the supporting data are reported here, we have not classified it as a supporting study. All of them reported on the number of people screened positive but did not do so in relation to an appropriate reference standard, thus making it impossible to determine the true number of cases.

Two studies reported entry and exit screening for COVID-19: [Jernigan 2020](#) assessed symptom-based entry screening in the USA; it reported on 46,016 individuals, of whom 11 (0.02%) screened positive and one was subsequently identified as a COVID-19 case.

[Sriwijitalai 2020a](#) reports that symptom- and temperature-based entry screening at an international airport has screened 12 individuals positively since December 2019, one of whom was subsequently identified as a COVID-19 case. The study does not report how many individuals were screened in this time period.

Two studies reported on entry and exit screening for SARS in Canada. In [Anonymous 2004](#), 4,569,759 travellers were screened using infrared scanning; of these 1435 (0.031%) tested positive and no SARS case was detected.

[St John 2005](#) screened 1,172,986 people using a symptom-based questionnaire, with 2889 (0.2%) testing positive and no SARS case detected. [St John 2005](#) also applied infrared scanning, screening 763,082 travellers, with 191 (0.03%) testing positive and no SARS case detected.

[Pang 2003](#) studied entry screening based on infrared scanning and temperature assessment in China, with 275,600 people screened, 496 (0.2%) testing positive and no SARS case detected.

[Wilder-Smith 2003](#) reported on entry and exit screening based on symptoms in Singapore. Out of 442,973 travellers screened, 136 (0.03%) screened positive and none was diagnosed with SARS.

## 3. Quarantine of travellers crossing national borders

### 3.1. COVID-19

We identified one modelling study ([Ryu 2020](#)), contributing evidence to quarantine of travellers as a standalone control measure. The modelling study reported on the number of cases seeded by imported cases. [Table 7](#) presents the GRADE evidence profile for this body of evidence. We assessed it as very low certainty because of risk of bias (quality), indirectness and imprecision.

### 3.1.1. Outcome category: cases avoided due to the measure

#### Number of cases seeded by imported cases

Ryu 2020, a deterministic SEIR model with major quality concerns related to the model's structural assumptions and input parameters, assessed the number of cases seeded by quarantined students arriving in South Korea from China to be generally low. The number of cases seeded decreases with increasing levels of compliance with the quarantine measures (ranging from 277 to 19 cases).

### 3.2. SARS

We identified one modelling study (Hsieh 2007), and one observational study (Hsieh 2005), contributing evidence to the quarantine of travellers as a standalone control measure in the context of SARS. The modelling study reported on the number of cases seeded by imported cases and the number of deaths, and the observational study reported data to enable the assessment of diagnostic outcomes. Table 7 presents the GRADE evidence profile for this body of evidence. We assessed these as very low certainty; we downgraded the evidence from the modelling study for indirectness and imprecision; we downgraded evidence from the observational studies for risk of bias, inconsistency, and indirectness.

#### 3.2.1. Outcome category: cases avoided due to the measure

##### Number of cases seeded by imported cases

Hsieh 2007, a discrete-time compartmental SIR modelling study with no major quality concerns, found that the isolation of two SARS cases from 95,828 screened travellers resulted in 29 fewer cases in Taiwan seeded by imported cases (5% reduction in number of expected cases). If quarantine of arriving travellers had been implemented at the beginning of the outbreak 17 additional SARS cases would have been quarantined, and as a result 280 cases seeded by imported cases would have been avoided (49% reduction in number of expected cases).

##### Number of deaths

Similarly, Hsieh 2007 reports that the isolation of two SARS cases from 95,828 quarantined travellers resulted in five fewer deaths in Taiwan resulting from imported cases (5% reduction in the number of expected deaths). If quarantine of arriving travellers had been implemented at the beginning of the outbreak, 48 SARS deaths would have been avoided (49% reduction in the number of observed deaths).

#### 3.2.2. Outcome category: cases detected due to the measure

##### Proportion of cases detected and positive predictive value

Hsieh 2005, an observational study with serious risk of bias, described quarantining 95,828 travellers returning to Taiwan from SARS-affected areas in 2003. No cases were detected among the incoming travellers. Given there were no cases, we cannot calculate the proportion of cases detected and positive predictive value. Wang 2007, an observational study very similar to Hsieh 2005, reported conflicting data on the same quarantine programme: among 95,271 quarantined travellers 56 were confirmed cases. We reached out to both author teams but were unable to determine the reason for the conflicting data.

## DISCUSSION

### Summary of main findings

To inform decisions on containing the COVID-19 pandemic, we set out to identify and synthesise the evidence on the effectiveness of international travel-related control measures during coronavirus outbreaks on infectious disease and screening-related outcomes. Our rapid review identified an expansive and heterogeneous evidence base, with studies focusing on a range of real or simulated travel-related control measures aiming to contain the COVID-19 pandemic, as well as the SARS epidemic and outbreaks of MERS.

### Findings of studies on COVID-19

We found 11 modelling studies and one observational ecological study on travel restrictions reducing cross-border travel, all modelling a range of reductions in travel across real or simulated countries. Very low-certainty evidence suggests that when implemented at the beginning of the outbreak, these measures may lead to a reduction in the number of new cases of between 26% to 90% (4 studies), in the number of deaths (1 study), in the time to outbreak of between 2 and 26 days (2 studies), in the risk of outbreak of between 1% to 37% (2 studies), and in the effective reproduction number (2 studies). Low-certainty evidence suggests a reduction in the number of imported or exported cases of between 70% to 81% (5 studies), and in the growth acceleration of the epidemic progression (1 study).

We found 12 studies on entry or exit screening with or without quarantine. Screening approaches included various combinations of symptom-based screening, single (and rarely repeated) PCR testing and observation during quarantine. Very low-certainty evidence suggests delays in outbreak of between 1 to 183 days (3 modelling studies); low-certainty evidence was found for a detection rate of infected travellers of between 10% to 53% (3 modelling studies). Very low-certainty evidence suggests that the proportion of cases detected ranged from 0% to 75% and that the positive predictive value ranged from 0% to 100% (6 observational studies). These outcomes, however, should be interpreted in relation to both the screening approach used and the prevalence of infection among the travellers screened; for example, symptom-based screening alone tended to perform worse than a combination of symptom-based and PCR screening with subsequent observation during quarantine.

We found one study on quarantine of travellers. Very low-certainty evidence suggests a reduction in the number of cases seeded by imported cases; larger reductions are seen with increasing levels of quarantine compliance (1 modelling study).

### Findings of studies on SARS and MERS

Four studies on SARS and one study reporting on both SARS and MERS examined screening at borders, and provide very low- to low-certainty evidence for reductions in imported cases, deaths, and varying results for detection of infected travellers, the proportion of cases detected and positive predictive value.

Three studies on SARS examined the impact of quarantine of travellers. Very low-certainty evidence suggests a reduction in the number of cases seeded by the imported cases and the number of deaths, and conflicting results for the proportion of cases detected.

None of the included studies on COVID-19, SARS or MERS examined effects on healthcare utilisation, resource requirements or any adverse effects.

## Overall completeness and applicability of the evidence

As expected, based on the experience with the previous evidence map (Burns 2020), we identified studies assessing a broad range of travel-related control measures to contain COVID-19, SARS and, much less so, MERS. They examined outcomes across all three a priori specified outcome categories and were conducted across multiple world regions. There were, however, some gaps in the evidence base, notably in relation to population, setting and interventions.

### Population

While most included studies focused on COVID-19, we also identified several studies concerned with SARS, and one study addressing SARS and MERS. Although we feel that this evidence is of value in the current situation, for some interventions, such as entry and exit screening, and quarantine, differences in characteristics like the incubation and infectious periods suggest that this evidence is less applicable to the control of COVID-19.

### Setting

Despite the range of countries covered by the studies included in this rapid review, we did not identify any evidence relating to the African and Eastern Mediterranean regions. Moreover, the COVID-19 entry and exit screening measures assessed here have thus far only been implemented in very specific settings, such as on evacuation flights or during cruise ship outbreaks. The only evidence regarding national entry and exit screening identified examined such measures being implemented during the SARS epidemic. Importantly, much of the evidence relates to the implementation of travel-related control measures at the beginning of the outbreak; we found very limited evidence from later phases during the outbreak or on the relaxation of travel-related control measures. As various countries consider when it is safe to lift restrictions, it will be important that studies assessing this aspect are available.

### Intervention

With much of the evidence deriving from modelling studies – notably for travel restrictions reducing cross-border travel and quarantine of travellers – there is a lack of 'real-life' evidence for many of these measures.

### Outcomes

The observational studies that examined screening and quarantine measures assessed the impact of these measures only on the proportion of infected individuals detected at the border; the modelling studies examined time to outbreak. While this is valuable information, insights into how screening and quarantine measures may further influence the development of the epidemic in the country of arrival are lacking. None of our included studies reported on outcomes related to the implementation of travel-related control measures (e.g. human and financial resources, healthcare utilisation) or adverse effects in terms of health (e.g. isolation), as well as broader social and economic implications (e.g. stigmatisation, inability to work, economic impacts). While it is possible that travel-related control measures generate signalling

effects in terms of raising general awareness or deterring effects in terms of stopping sick individuals from travelling, we did not identify any evidence on these. This represents a major limitation regarding completeness of the evidence. This finding was not unexpected as our previous evidence map, which employed a broader scope and searched medical as well as non-medical databases, showed that such outcomes were very rarely addressed in studies (Burns 2020). There may, however, be a body of evidence that looks specifically at the implementation and costs of travel-related control measures (e.g. government reports) and at the societal impact and likely societal harms of such measures (e.g. economic and social sciences literature). At the outset, it was decided in consultation with WHO that the most pressing question at this point related to the effectiveness of travel-related control measures and that this review should thus focus primarily on studies assessing effectiveness in relation to the infectious disease transmission and screening-related outcomes; if included studies also reported on harms, those harms would also be included; and that, subsequently, a likely more complex and time-consuming review on the multiple harms of travel-related control measures could be conducted.

### Sources of heterogeneity

While we did not assess heterogeneity in the effects of travel-related control measures using subgroup analyses, we should note that there is likely to be much heterogeneity, depending on the stage of the epidemic, accompanying measures to control community transmission, the interconnectedness of countries, as well as the extent of and enforcement of implementation. While, across the range of modelling and observational studies, these issues are not addressed in any detail, selected studies have described (rather than assessed) or modelled factors that influence effectiveness. These represent pointers – rather than conclusive evidence – towards the importance of these factors.

- Travel-related control measures target one specific source of transmission, that is, human travel. The importance of this source of transmission in influencing overall epidemic development depends on the stage of the epidemic in the region restricted and the region protected by the measure (i.e. high versus low levels of community transmission), as well as differentials between them. Especially during the early stages of an epidemic or pandemic, when there are no or only few cases in the region protected by the measure, travel-related control measures may be an effective means to delay an outbreak.
- Similarly, the significance of human travel as a potential source of transmission is likely to vary with the volume of travel (e.g. few versus many flights per day arriving in a small island state) and the degree of interconnectedness of countries (e.g. having a land border with just two countries versus having land borders with 10 countries).
- As most evidence on travel-related control measures (with the notable exception of entry and exit screening) stems from modelling studies and given the lack of detailed specifications of these measures in these studies, we described broad categories of travel-related control measures. Of course, as observed in countries around the world, the specification of measures within these broad categories varies greatly with regards to who is targeted (e.g. all travellers versus specific groups), which borders or means of transport are affected (e.g. travel by air, land or sea), combinations with other travel-related

measures (e.g. wearing of masks, hygiene, physical distancing), as well as the exact design (e.g. single PCR test versus repeated PCR tests), 'dose' (e.g. complete versus partial border closure) and duration (e.g. seven-day quarantine versus 14-day quarantine). Importantly, degree of adherence and, where applied, enforcement of the measure (e.g. recommendation to quarantine, various forms of control, fine and magnitude of fine) are also likely to play an important role.

Travel-related control measures rarely operate in a vacuum but tend to be implemented as part of a broad suite of measures to control community transmission (e.g. testing, contact tracing, social distancing measures, wearing of face masks). Their overall contribution to controlling the epidemic is therefore likely to vary depending on the number and types of other measures implemented.

### Certainty of the evidence

Certainty of evidence was either low or very low for every body of evidence we assessed, thus we cannot be confident in the findings. We downgraded certainty of the evidence due to risk of bias (for observational studies) and quality (for modelling studies), as well as inconsistency, imprecision, and indirectness.

Observational studies assessing entry and exit screening measures were all found to be at high risk of bias for at least one domain, and all but one were at high risk of bias due to the reference test employed. Procedures varied, but most studies used a time frame of 14 days during which to confirm cases based on symptom observation or PCR testing, or both, of those developing symptoms. In light of the risk of false negatives with PCR testing and the fact that testing was limited to those showing symptoms in some of the studies, it is possible that cases were missed. The only other observational study, an ecological study assessing the effect of several travel-related control measures in a cross-country comparison, was also at high risk of bias, mostly due to confounding and unreliable outcome data. Although modelling studies ranged in quality, most bodies of evidence comprising modelling studies were downgraded due to serious or very serious concerns about the quality of the modelling. Quality concerns were diverse, but included assumptions related to model structure and input data, and the lack of assessment of uncertainty. Problematic assumptions for any of these aspects could lead to results that do not reflect reality and are thus of limited utility.

We downgraded evidence for inconsistency, when the studies contributing to the same body of evidence reported conflicting data, or when estimates of effect showed large variation across studies (e.g. delay in outbreak from days to years).

Regarding imprecision, many of the modelling studies provided estimates of effect (e.g. 85 deaths avoided), without any information on the precision of the estimates. Given the nature of the data and models, it is plausible that the uncertainty in estimates is wide, and such information would be necessary for an appropriate interpretation of the study. We also downgraded evidence for imprecision when a body of evidence comprised a single modelling study, as it limits our confidence in the predictions being a precise estimate of true effects.

We applied three reasons for downgrading based on indirectness. Although we consider evidence from the SARS and MERS

pandemics to be relevant to the current pandemic, differences around its transmission (e.g. duration of the incubation and infectiousness periods) mean that evidence from these other coronaviruses may not be fully applicable to COVID-19; thus bodies of evidence comprising SARS or MERS evidence were downgraded. Where exit and entry screening measures were implemented in very specific settings, such as on evacuation flights or during cruise ship outbreaks, we also considered this indirect evidence with regards to informing more general entry and exit screening measures at national borders. Finally, for bodies of evidence based on modelling studies, we downgraded evidence for indirectness for lack of model external validation, as it created uncertainties in assessing how directly the model outputs relate to our review question.

### Potential biases in the review process

Despite the very tight timeline, we applied systematic and transparent methods throughout the phases of the review process. We defined our review objective and scope informed by a previously conducted evidence map (Burns 2020), and in consultation with WHO – a key end-user of the findings of this review that specifically requested the review to inform WHO recommendations on travel-related control measures for COVID-19. Our protocol was reviewed and approved by Cochrane (see Appendix 1). In order to describe the emerging evidence in relation to COVID-19, we included a wide range of study designs and publication types, including modelling studies and preprint publications. We summarised this evidence narratively, but applied GRADE to assess the certainty of evidence for all primary outcomes. We did, however, encounter challenges in dealing with this complex evidence base, and some decisions we made may have introduced bias into the review process.

Although we used a comprehensive search strategy designed by an information specialist, we conducted searches in only two major databases and three COVID-specific databases and used specific search terms tightly defined around travel-related control measures. While our chosen databases include records from a wide range of databases, as well as grey literature, such as preprints, it is possible that our searches missed some studies, especially if those were not framed broadly or appropriately indexed in the journals and preprint servers. This also concerns our lack of findings regarding implementation outcomes and adverse effects. Had we searched a broad range of multi-disciplinary databases and had we undertaken systematic searches of the grey literature, we may have identified some of these outcomes – albeit at the cost of a much lengthier and more complex review process. As described above, our review included many modelling studies: in the specific context of a global pandemic, models developed to make predictions about the future often represent the only available evidence, and are therefore crucial in informing decision making. Many modelling studies did not provide comprehensive reporting of key assumptions and model parameters, which created challenges in assessing their eligibility, for example in decisions on whether the model used disease parameters of relevance for our review. To date, a validated tool to assess the risk of bias of modelling studies does not exist. Based on input received from Cochrane and GRADE Working Group colleagues as well as other experts, we constructed a bespoke tool to appraise the quality of modelling studies. We also included modelling experts within our review team during protocol development and throughout the review process. Nevertheless, we made a post-protocol decision to adapt two criteria in the quality

appraisal tool, however, this did not change the structure of the tool.

Finally, we experienced some difficulty with applying the GRADE guidance for assessing the certainty of evidence based on modelling studies (Brozek 2020), most importantly, because it does not offer guidance for operationalising the assessment of risk of bias/quality, indirectness, imprecision, inconsistency and publication bias for a body of evidence comprising multiple models. Notably, applying the criteria inconsistency (travel-related control measures by design generally show at least a slight positive or no effect, not a negative effect) and imprecision (high-quality models vary, a large number of parameters and scenarios often leading to wide confidence intervals, poor-quality models do not even allow for an assessment of imprecision) was challenging. Furthermore, we used external model validation as a key criterion to help in our judgments on indirectness of the evidence, which is, however, not currently specified and operationalised as such in the GRADE guidance.

Finally, we used abridged procedures of systematic reviewing at certain stages, to enable rapid completion of this review. Specifically, we did not conduct double data extraction and assessment of risk of bias. However, we had a second experienced review author check all the extracted and appraised evidence and discussed and resolved any uncertainties. Furthermore, we single-screened titles and abstracts but double-screened all studies excluded at the title and abstract screening stage; we undertook double screening of all records at full text. With a large author team potentially introducing heterogeneity in the process, we set up groups of three to four review authors working on each specific task (e.g. screening, extraction) to minimise inconsistencies. We also organised regular calls and discussions within these groups to discuss any issues and harmonise the review process.

## AUTHORS' CONCLUSIONS

### Implications for practice

The certainty of evidence included in this rapid review is low to very low, due to the nature as well as quality and heterogeneity of available studies. Therefore, true effects may be substantially different from those reported here. Nevertheless, this review suggests that some travel-related control measures during outbreaks of COVID-19, SARS, and MERS have a positive impact on infectious disease outcomes, notably on reducing the number of (imported) cases and on delaying or reducing epidemic development. Broadly, travel restrictions reducing cross-border travel may limit the spread of disease across national borders. Entry and exit symptom screening measures on their own are not likely to be effective in detecting a meaningful proportion of cases to prevent seeding new cases within the region protected by the measure; combined with PCR testing, quarantine and observation the effectiveness is likely to improve. For travel-related quarantine on its own, we did not find enough evidence to draw firm conclusions. However, the situation is complex, and the dynamic nature of pandemic development should be considered. Specifically, some of the included studies suggest that effects are likely to depend on factors, such as the stage of the epidemic in the region protected as well as the region restricted by a given measure, local measures in place to control community transmission (e.g. physical distancing, face covering), the interconnectedness of countries, as well as the extent and

enforcement of implementation. As the pandemic progresses, decision-makers can implement/increase or de-implement/loosen a range of potentially appropriate measures, and, in doing so, consider the above described factors. Importantly, travel-related control measures affect health and society in much broader ways, and decisions will need to balance all benefits and potential harms associated with a specific measure (not assessed in this review).

### Implications for research

Decision-makers need high-quality research that helps to inform the decisions they continually have to make to chart the course through the COVID-19 pandemic. Research should be responsive to the questions most urgently raised by decision-makers, such as how can travel restrictions help in delaying a second wave, how do entry and exit screening and traveller's quarantine need to be specified and enforced to maximise the benefit-harm balance, and at what point is it safe to relax travel-related control measures. It would also be important that studies explicitly assess the factors that might influence the effectiveness of travel-related control measures, such as the stage of the pandemic and accompanying measures to control community transmission. Some of these questions may be answered quickly by refining existing models; importantly, however, the pandemic also presents an opportunity for critical questions to be answered through rigorous data collection and analysis. In observational studies assessing the effectiveness of border screening measures, it would be critical to go beyond the number of cases detected and to consider the impact of these measures on the spread and development of the epidemic in the community. Further, research into the effectiveness of travel-related PCR testing and travel-related quarantine should also systematically assess and report on the number of cases missed by these measures. Similarly, it would be important to further explore the real-world specificity of PCR testing, as in populations with low prevalence of the disease mass testing might yield a high false positive rate.

As many governments currently employ travel-related control measures as well as a range of other public health measures to contain the pandemic, moving forward, it would be important to assess various combinations of these measures to identify those that are most effective. This concerns both primary research and future systematic reviews. Finally, to ensure that the best available evidence informs difficult and evolving decisions, future research should employ a range of epidemiological designs and assessment tools to assess the broad impacts of travel-related control measures, including all potential benefits and harms from a health and broader societal perspective.

### Review protocol

The protocol for this systematic review, as reviewed and agreed upon by Cochrane, can be found in [Appendix 1](#).

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## CHARACTERISTICS OF STUDIES

### Characteristics of included studies [ordered by study ID]

#### Adekunle 2020

##### Study characteristics

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | Mathematical modelling study <ul style="list-style-type: none"> <li>Description: stochastic meta-population SEIR model <ul style="list-style-type: none"> <li>* Global stochastic meta-population SEIR model with 2 infectious stages (both symptomatic, 1 with lower infectiousness) using migration patterns based on international flight travel volumes to estimate the impact of a travel ban.</li> </ul> </li> </ul>                                                                            |
| Disease                             | COVID-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Travel-related control measure(s)   | International travel restrictions/bans <ul style="list-style-type: none"> <li>Description: <ul style="list-style-type: none"> <li>* Wuhan lockdown and travel ban on China</li> <li>* travel ban on Iran, South Korea and Italy</li> </ul> </li> <li>Date of implementation: different travel bans implemented progressively since 24 January 2020</li> <li>The travel-related control measures are operationalised in the model as reductions in mobility based on historical travel data</li> </ul> |
| Country implementing the measure(s) | Australia <p>Region protected by the measure: Australia</p> <p>Region restricted by the measure: China, Iran, South Korea, and Italy</p>                                                                                                                                                                                                                                                                                                                                                              |
| Outcome(s)                          | Cases avoided due to intervention <ul style="list-style-type: none"> <li>Outcome: number of imported cases avoided</li> <li>Follow-up: 1 December 2019–24 March 2020</li> </ul>                                                                                                                                                                                                                                                                                                                       |
| Notes                               | Col: "The authors have stated they have no conflict of interest"                                                                                                                                                                                                                                                                                                                                                                                                                                      |

## Adekunle 2020 (Continued)

Funding: not reported

## Anderson 2020

### Study characteristics

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | Mathematical modelling study <ul style="list-style-type: none"> <li>Description: extended Bayesian SEIR model <ul style="list-style-type: none"> <li>* Complex Bayesian SEIR model with a compartment for quarantine and 2 exposed stages (non-infectious and infectious).</li> <li>* Includes modelling of a fixed proportion of the population participating in social distancing behaviour and is estimated separately for each jurisdiction</li> </ul> </li> </ul> |
| Disease                             | COVID-19                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Travel-related control measure(s)   | Closure of national borders <ul style="list-style-type: none"> <li>Description: relaxation of the closure of national borders</li> <li>Date of implementation: not specified</li> </ul>                                                                                                                                                                                                                                                                                |
| Country implementing the measure(s) | Belgium; Canada (Ontario; Quebec; British Columbia); Germany; Japan; New Zealand; Sweden; UK; USA (California, New York, Washington) <ul style="list-style-type: none"> <li>Region protected by the measure: Belgium; British Columbia; California; Germany; Japan; New York; New Zealand; Ontario; Quebec; Sweden; UK; Washington</li> <li>Region restricted by the measure: other countries (not specified)</li> </ul>                                               |
| Outcome(s)                          | Cases avoided due to intervention <ul style="list-style-type: none"> <li>Outcome: number of additional cases introduced when one infected traveller enters</li> <li>Follow-up: 6 weeks after relaxation</li> </ul>                                                                                                                                                                                                                                                     |
| Notes                               | Col: not reported<br><br>Funding: "The authors have stated they have no conflict of interest"                                                                                                                                                                                                                                                                                                                                                                          |

## Anonymous 2004

### Study characteristics

|                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                      | Observational screening study                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Disease                           | SARS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Travel-related control measure(s) | Entry and exit screening based on infrared scanning <ul style="list-style-type: none"> <li>Description <ul style="list-style-type: none"> <li>* Thermal screening of arriving and departing passengers at Pearson International Airport, Toronto, Canada and Vancouver International Airport, Vancouver, Canada;</li> <li>* Referral of passengers with elevated temperatures to a screening nurse for a medical assessment (i.e. oral temperature and administration of a standardised questionnaire for SARS)</li> </ul> </li> <li>Date of implementation: Toronto, 16 May 2003; Vancouver, 23 May 2003</li> </ul> |

## Anonymous 2004 (Continued)

|                                     |                                                                                                                                                                                                                                                          |
|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Country implementing the measure(s) | Canada <ul style="list-style-type: none"> <li>Region protected by the measure: Canada</li> <li>Region restricted by the measure: all other countries</li> </ul>                                                                                          |
| Outcome(s)                          | Number of cases detected due to the intervention <ul style="list-style-type: none"> <li>Outcome 1: number of positive screening outcomes</li> <li>Outcome 2: number of true positive screening outcomes detected</li> <li>Follow-up: 6 months</li> </ul> |
| Notes                               | Col: not reported<br><br>Funding: not reported                                                                                                                                                                                                           |

## Anzai 2020

### Study characteristics

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | Mathematical modelling study <ul style="list-style-type: none"> <li>Description: counterfactual projection model based on Poisson process <ul style="list-style-type: none"> <li>* The model assumes a Poisson process determining exported cases to destination countries from China and the probability of a major epidemic in destination countries based on a negative binomial distribution of generated secondary cases.</li> <li>* This counterfactual projection is compared to observed exported cases.</li> <li>* Model allows for untraced cases and imperfect contact tracing.</li> </ul> </li> </ul> |
| Disease                             | COVID-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Travel-related control measure(s)   | International travel restrictions/bans<br><br>Entry screening at national borders<br><br>Quarantine of travellers crossing national borders <ul style="list-style-type: none"> <li>Description: <ul style="list-style-type: none"> <li>* complete travel bans</li> <li>* travel restrictions and quarantine, and</li> <li>* entry screening for all incoming travellers, or some combination thereof</li> </ul> </li> <li>Date of implementation: 23 January 2020</li> <li>The travel-related control measures are operationalised in the model as a reduction in travel volumes</li> </ul>                       |
| Country implementing the measure(s) | Not specified/Japan for outcome 2 <ul style="list-style-type: none"> <li>Region protected by the measure: not specified/Japan for outcome 2</li> <li>Region restricted by the measure: China</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                           |
| Outcome(s)                          | Cases avoided due to intervention <ul style="list-style-type: none"> <li>Outcome 1: number of exported out cases from China</li> <li>Follow-up: 28 January–6 February 2020</li> </ul> Shift in epidemic due to the intervention <ul style="list-style-type: none"> <li>Outcome 2: absolute risk reduction in the probability of major epidemic</li> <li>Follow-up: 28 January–6 February 2020</li> </ul>                                                                                                                                                                                                          |

### Travel-related control measures to contain the COVID-19 pandemic: a rapid review (Review)

## Anzai 2020 (Continued)

Shift in epidemic due to the intervention

- Outcome 3: time to a major epidemic
- Follow-up: 28 January–6 February 2020

Notes

Col: “The authors declare no conflicts of interest”.

Funding: “H.N. received funding from the Japan Agency for Medical Research and Development (AMED) [grant number: JP18fk0108050]; the Japan Society for the Promotion of Science (JSPS) KAKENHI [grant numbers, H.N.: 17H04701, 17H05808, 18H04895 and 19H01074; R.K.: 18J21587; AS.: 19K24159], the Inamori Foundation, and the Japan Science and Technology Agency (JST) CREST program [grant number: JPMJCR1413]. SMJ and NML receive graduate study scholarships from the Ministry of Education, Culture, Sports, Science and Technology, Japan”

## Arima 2020

### Study characteristics

Study design

Observational screening study

Disease

COVID-19

Travel-related control measure(s)

Evacuation flight: entry/exit screening at national borders and quarantine of travellers

- Entry screening procedures:
  - \* likely-symptom-focused clinical examination and
  - \* RT-PCR of oropharyngeal swab samples
- Quarantine procedures: quarantine of all passengers tested negative for 14 days
- Reference test for entry/exit screening:
  - \* Observation of cases during quarantine
  - \* PCR test for all those who developed symptoms during quarantine,
  - \* RT-PCR test of oropharyngeal swab samples on day 1 and
  - \* at the end of the 14-day quarantine period for all asymptomatic passengers
- Reference test for quarantine observation:
  - \* PCR test for all those who developed symptoms during quarantine,
  - \* RT-PCR test of oropharyngeal swab samples on day 1 and
  - \* at the end of the 14 day quarantine period for all asymptomatic passengers
- Date of implementation: 29-31 January 2020 (evacuation flights)

Country implementing the measure(s)

Canada

- Region protected by the measure: Tokyo, Japan
- Region restricted by the measure: Hubei Province, China

Outcome(s)

Number of cases detected due to the intervention

- Outcome 1: sensitivity (symptom screening)
- Outcome 2: positive predictive value (symptom screening)
- Outcome 3: sensitivity (PCR screening)
- Outcome 4: positive predictive value (PCR screening)
- Outcome 5: sensitivity (combined symptom and PCR screening)
- Outcome 6: positive predictive value (combined symptom and PCR screening)
- Follow-up: 29-31 January 2020 (evacuation flights), with follow-up reference testing

Notes

Col: not reported

## Arima 2020 (Continued)

Funding: "This study was supported in part by a grant-in-aid from the Japan Agency for Medical Research and Development (grant nos. JP19fk0108104 and JP19fk0108110)"

## Banholzer 2020

### Study characteristics

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | Mathematical modelling study <ul style="list-style-type: none"> <li>Description: Bayesian hierarchical model <ul style="list-style-type: none"> <li>* The number of new cases (modelled based on a negative binomial distribution) is linked to the number of existing cases, country and time parameters and the presence of any NPIs (assumed to have the same effectiveness in each country).</li> <li>* The model then, under a counterfactual scenario, estimates the relative reduction in new cases.</li> </ul> </li> </ul> |
| Disease                             | COVID-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Travel-related control measure(s)   | Closure of national borders <ul style="list-style-type: none"> <li>Description: closure of national borders for individuals representing severe restrictions in international travel</li> <li>Date of implementation: varied in 12 countries implementing the measure</li> </ul>                                                                                                                                                                                                                                                   |
| Country implementing the measure(s) | Austria, Australia, Belgium, Canada, Denmark, France, Finland, Italy, Norway, Switzerland, Spain, USA <ul style="list-style-type: none"> <li>Region protected by the measure: Austria, Australia, Belgium, Canada, Denmark, France, Finland, Italy, Norway, Switzerland, Spain, USA</li> <li>Region restricted by the measure: all other countries</li> </ul>                                                                                                                                                                      |
| Outcome(s)                          | Cases avoided due to intervention <ul style="list-style-type: none"> <li>Outcome: relative reduction in number of new cases</li> <li>Follow-up: through 15 April 2020</li> </ul>                                                                                                                                                                                                                                                                                                                                                   |
| Notes                               | Col: "SF reports further grants from the Swiss National Science Foundation outside of the submitted work. JPS declares part-time employment at Luciole Medical outside of the submitted work. All other authors declare no competing interests."<br><br>Funding: "NB, EvW and SF acknowledge funding from the Swiss National Science Foundation (SNSF) as part of the Eccellenza grant 186932 on 'Data-driven health management'".                                                                                                 |

## Boldog 2020

### Study characteristics

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design | Mathematical modelling study <ul style="list-style-type: none"> <li>Description: time-dependant SEIR model as input for global transportation network model and Galton-Watson branching process in destination. <ul style="list-style-type: none"> <li>* A time-dependent SEIR model is used to model transmission dynamics and estimate the cumulative number of cases, which is then used as an input parameter for a global transportation network model which generates probability distributions of the number of exported cases at each destination. Finally, a Galton-Watson branching process in each destination country estimates the probability of a major outbreak.</li> <li>* Gamma distributed incubation and infectious period based on SARS-study.</li> </ul> </li> </ul> |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## Boldog 2020 (Continued)

|                                     |                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Disease                             | COVID-19                                                                                                                                                                                                                                                                                                                                                                           |
| Travel-related control measure(s)   | <p>International travel restrictions/bans</p> <p>Entry screening</p> <ul style="list-style-type: none"> <li>Description: not specified</li> <li>Date of implementation: not specified</li> <li>The travel-related control measures are operationalised in the model as 25%, 50% and 75% reductions in travel connectivity to China.</li> </ul>                                     |
| Country implementing the measure(s) | <p>Canada, South Korea, Thailand and USA</p> <ul style="list-style-type: none"> <li>Region protected by the measure: Canada, South Korea, Thailand and USA</li> <li>Region restricted by the measure: China</li> </ul>                                                                                                                                                             |
| Outcome(s)                          | <p>Shift in epidemic development due to the intervention</p> <ul style="list-style-type: none"> <li>Outcome: risk of major outbreak</li> <li>Follow-up: NA</li> </ul>                                                                                                                                                                                                              |
| Notes                               | <p>Col: "The authors declare no conflict of interest".</p> <p>Funding: "G.R. was supported by EFOP-3.6.1-16-2016-00008. F.B. was supported by NKFIH KKP 129877. T.T. was supported by NKFIH FK 124016. A.D. was supported by NKFIH PD 128363 and by the János Bolyai Research Scholarship of the Hungarian Academy of Sciences. P.B. was supported by 20391-3/2018/FEKUSTRAT".</p> |

## Chinazzi 2020

### Study characteristics

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | <p>Mathematical modelling study</p> <ul style="list-style-type: none"> <li>Description: individual-based, stochastic, and spatial meta-population epidemic model <ul style="list-style-type: none"> <li>* The global epidemic and mobility model (GLEAM) uses a meta-population network approach, which divides the real-world population in subpopulations centred around transportation hubs. Ground and air travel mobility flows are estimated from real-world data and transmission dynamics are estimated in each subpopulation using a SEIR model.</li> <li>* Model assumes the detection of imported cases to not be lower than 40% and travel probabilities, susceptibility and contact patterns to be homogenous</li> </ul> </li> </ul> |
| Disease                             | COVID-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Travel-related control measure(s)   | <p>International travel restrictions/bans</p> <ul style="list-style-type: none"> <li>Description: international travel restrictions on China, including suspension and limitation of flights to and from China</li> <li>Date of implementation: Wuhan travel ban implemented on 23 January 2020; China travel restrictions implemented on 1 February 2020</li> <li>The travel-related control measures are operationalised in the model as 40% and 90% reductions in international travel to and from China</li> </ul>                                                                                                                                                                                                                            |
| Country implementing the measure(s) | <p>Various countries (not specified)</p> <ul style="list-style-type: none"> <li>Region protected by the measure: various (not specified)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

## Chinazzi 2020 (Continued)

- Region restricted by the measure: China

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Outcome(s) | <p>Cases avoided due to intervention</p> <ul style="list-style-type: none"> <li>• Outcome: number of imported cases</li> <li>• Follow-up: 1 January–1 March 2020</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Notes      | <p>Col: "M.E.H. reports grants from the National Institute of General Medical Sciences during the conduct of the study; A.V. reports grants and personal fees from Metabiota, Inc., outside of the submitted work; M.C. and A.P.yP. report grants from Metabiota, Inc., outside of the submitted work; H.Y. reports grants from Glaxosmithkline (China) Investment Co., Ltd., Yichang HEC Changjiang Pharmaceutical Co., Ltd, Sanofi Pasteur, and Shanghai Roche Pharmaceuticals Company, outside of the submitted work. The authors declare no other relationships or activities that could appear to have influenced the submitted work".</p> <p>Funding: "M.E.H. acknowledges the support of the MIDASU54GM111274. S.M. and M.A. acknowledge support from the EU H2020 MOOD project. C.G. and L.R. acknowledge support from the EU H2020 Icarus project. M.C. and A.V. acknowledge support from Google Cloud Healthcare and Life Sciences Solutions via the GCP research credits program. The findings and conclusions in this study are those of the authors and do not necessarily represent the official position of the funding agencies, the National Institutes of Health, or the U.S. Department of Health and Human Services"</p> |

## Clifford 2020

### Study characteristics

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | <p>Mathematical modelling study</p> <ul style="list-style-type: none"> <li>• Description: Poisson process and local outbreak model <ul style="list-style-type: none"> <li>* The model integrates a stochastic non-homogeneous Poisson process estimating arrival of infected travellers with a local outbreak probability model where interventions increase probability of identification of infected cases or reduce the reproductive number and thus reduce outbreak probability.</li> <li>* Individuals with severe symptoms are assumed not to attempt travel.</li> </ul> </li> </ul> |
| Disease                             | COVID-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Travel-related control measure(s)   | <p>Entry/exit screening</p> <ul style="list-style-type: none"> <li>• Description: <ul style="list-style-type: none"> <li>* no screening</li> <li>* exit screening only, and</li> <li>* exit and entry screening</li> </ul> </li> <li>• Date of implementation: not applicable</li> </ul>                                                                                                                                                                                                                                                                                                   |
| Country implementing the measure(s) | <p>Not specified</p> <ul style="list-style-type: none"> <li>• Region protected by the measure: not specified</li> <li>• Region restricted by the measure: not specified</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                         |
| Outcome(s)                          | <p>Shift in epidemic development due to the intervention</p> <ul style="list-style-type: none"> <li>• Outcome: delay of outbreak</li> <li>• Follow-up: not applicable</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                           |
| Notes                               | Col: "We declare no competing interests"                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

## Clifford 2020 (Continued)

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## Costantino 2020

### Study characteristics

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | Mathematical modelling study <ul style="list-style-type: none"> <li>Description: Poisson process and age-specific, deterministic extended SEIR model <ul style="list-style-type: none"> <li>The model assumes a Poisson process to estimate the possible true epidemic curve in China and then calculates the number of infected entering the country. An age-specific deterministic compartmental (susceptible (S), latent traced (Et), latent untraced (Eu), infectious (I), isolated (Q), recovered (R) and dead (D)) is then used to estimate transmission dynamics due to imported cases.</li> <li>The proportion of asymptomatic infections is assumed to be 34.6% and notified cases reflect only 10% of real infections per day.</li> </ul> </li> </ul> |
| Disease                             | COVID-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Travel-related control measure(s)   | International travel restrictions/bans <ul style="list-style-type: none"> <li>Description: <ul style="list-style-type: none"> <li>no travel ban</li> <li>complete travel ban followed by complete lifting of the ban, and</li> <li>complete travel ban followed by partial lifting of the ban (allowing university students, but not tourists, to enter the country)</li> </ul> </li> <li>Date of implementation: 1 February 2020</li> </ul>                                                                                                                                                                                                                                                                                                                    |
| Country implementing the measure(s) | Australia                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

### Travel-related control measures to contain the COVID-19 pandemic: a rapid review (Review)

**Costantino 2020** (Continued)

- Region protected by the measure: Australia
- Region restricted by the measure: China

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Outcome(s) | <p>Cases avoided due to intervention</p> <ul style="list-style-type: none"> <li>• Outcome 1: number of exported cases from China</li> <li>• Outcome 2: number of cases in Australia</li> <li>• Outcome 3: number of deaths in Australia</li> <li>• Follow-up: 400 days</li> </ul> <p>Shift in epidemic development due to the intervention</p> <ul style="list-style-type: none"> <li>• Outcome 4: delay of the epidemic outbreak</li> <li>• Follow-up: 400 days</li> </ul> |
| Notes      | <p>Col: "The authors declare no conflicts of interest"</p> <p>Funding: "This work has no funding"</p>                                                                                                                                                                                                                                                                                                                                                                       |

**Glass 2006**
**Study characteristics**

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | <p>Mathematical modelling study</p> <ul style="list-style-type: none"> <li>• Description: Unspecified transmission model <ul style="list-style-type: none"> <li>* The model calculates the prevalence of disease and the proportion of individuals attempting to travel in the infected region to estimate the number of travellers. The probability of detection through border screening is then used to predict the probability of a major epidemic in the uninfected region.</li> <li>* Depletion of susceptible individuals was ignored, as all scenarios assumed that the measures were able to interrupt transmission before a substantial fraction of the community became infected and onset of infectivity was assumed to coincide with the onset of symptoms.</li> </ul> </li> </ul> |
| Disease                             | SARS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Travel-related control measure(s)   | <p>Border screening</p> <ul style="list-style-type: none"> <li>• Description: symptomatic border screening was applied between the infected and uninfected regions, ignoring any transmission during travel</li> <li>• Date of implementation: not applicable</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Country implementing the measure(s) | <p>Not specified</p> <ul style="list-style-type: none"> <li>• Region protected by the measure: not specified</li> <li>• Region restricted by the measure: not specified</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Outcome(s)                          | <p>Number of cases detected due to the intervention</p> <ul style="list-style-type: none"> <li>• Outcome: proportion of infected travellers detected by screening (sensitivity)</li> <li>• Follow-up: not specified</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Notes                               | <p>Col: "None"</p> <p>Funding: "The authors gratefully acknowledge financial support from the Australian NHMRC grants 224215 (K.G.) and 148919 (N.G.B.), and the Australian Research Council Grant DP055847 (K.G. and N.G.B.)"</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

## Gostic 2015

### Study characteristics

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | Mathematical modelling study <ul style="list-style-type: none"> <li>Description: unspecified probabilistic model <ul style="list-style-type: none"> <li>* The model estimates the distribution of time since exposure of individuals attempting travel based on natural disease history parameters.</li> <li>* Travellers are assigned to one of four detectability classes at the time of intended departure: fever present with symptom onset, aware of risk factors, neither or both. Travellers pass through departure and arrival screening and are identified based on their class.</li> <li>* All infected are assumed to become symptomatic and are removed from the pool of potential travellers</li> </ul> </li> </ul> |
| Disease                             | SARS and MERS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Travel-related control measure(s)   | Entry/exit screening at national borders <ul style="list-style-type: none"> <li>Description: <ul style="list-style-type: none"> <li>* departure screening</li> <li>* departure and arrival screening consisting of infrared thermal scanners for fever (sensitivity: 70%) and exposure-focused questionnaire (25% probability of honest self-reporting if aware of exposure)</li> </ul> </li> <li>Date of implementation: not applicable</li> </ul>                                                                                                                                                                                                                                                                              |
| Country implementing the measure(s) | Not specified <ul style="list-style-type: none"> <li>Region protected by the measure: not specified</li> <li>Region restricted by the measure: not specified</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Outcome(s)                          | Number of cases detected due to the intervention <ul style="list-style-type: none"> <li>Outcome: proportion of infected travellers detected by screening (sensitivity)</li> <li>Follow-up: not applicable</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Notes                               | Col: not reported <p>Funding: The study mentions the following funders: National Institutes of Health for K.M.G. (T32-GM008185), Medical Research Council for A.J.K. (MR/K021524/1), U.S. Department of Homeland Security for J.O.L-S. and A.J.K. (RAPIDD Program), Fogarty International Center for J.O.L-S. and A.J.K. (RAPIDD Program), and National Science Program for J.O.L-S. (EF-0928690).</p>                                                                                                                                                                                                                                                                                                                           |

## Gostic 2020

### Study characteristics

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design | Mathematical modelling study <ul style="list-style-type: none"> <li>Description: unspecified probabilistic model <ul style="list-style-type: none"> <li>* Same as <a href="#">Gostic 2015</a> with COVID-19-specific disease parameters and extensions pertaining to <ul style="list-style-type: none"> <li><input type="checkbox"/> ways in which infected travellers can be missed</li> <li><input type="checkbox"/> fraction of subclinical cases</li> <li><input type="checkbox"/> the incubation period distribution</li> </ul> </li> </ul> </li> </ul> |
| Disease      | COVID-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

**Gostic 2020** (Continued)

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Travel-related control measure(s)   | <p>Entry/exit screening at national borders</p> <ul style="list-style-type: none"> <li>Description: hypothetical thermal infrared fever scanner and exposure-focused questionnaire at <ul style="list-style-type: none"> <li>* departure</li> <li>* arrival</li> <li>* departure and arrival</li> </ul> </li> <li>Date of implementation: not applicable</li> </ul>                                                                                                                                                                                                                                                                                                                                                                               |
| Country implementing the measure(s) | <p>Not specified</p> <ul style="list-style-type: none"> <li>Region protected by the measure: not specified</li> <li>Region restricted by the measure: not specified</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Outcome(s)                          | <p>Number of cases detected due to the intervention</p> <ul style="list-style-type: none"> <li>Outcome: proportion of infected travellers detected by screening (sensitivity)</li> <li>Follow-up: not applicable</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Notes                               | <p>Col: not reported</p> <p>Funding: the study mentions the following funders: James S. McDonnell Foundation for funding K.G. (postdoctoral fellowship in dynamic and multi-scale systems), Wellcome for funding A.J.K. (206250/Z/17/Z), Coordenação de Aperfeiçoamento de Pessoal de Nível Superior for A.C.R. G. (science without borders fellowship), National Science Foundation for J.O.L-S (DEB-1557022), Defense Advanced Research projects Agency for J.O.L-S (PREEMPT D18AC00031), and Strategic Environmental Research and Development Program for A.C.R.G, R.O.M, and J.O.L-S (RC-2635).</p> <p>“The funders had no role in study design, data collection and interpretation, or the decision to submit the work for publication”.</p> |

**Goubar 2009**
**Study characteristics**

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | <p>Mathematical modelling study</p> <ul style="list-style-type: none"> <li>Description: unspecified <ul style="list-style-type: none"> <li>* The model predicts the number of unobserved secondary infections based on the number of cases with symptom onset currently observed and back-calculates observed and predicted number of incident cases. It then uses the distribution of time since symptom onset to calculate the probability of departing and arriving undetected at a destination (importation rate is based on a non-homogeneous Poisson process) where individuals are detected based on current disease status.</li> <li>* In-flight transmission from incubating travellers deemed unlikely while symptomatic travellers might generate infections in-flight.</li> </ul> </li> </ul> |
| Disease                             | SARS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Travel-related control measure(s)   | <p>Entry screening</p> <ul style="list-style-type: none"> <li>Description: symptom-based entry screening of passengers in Frankfurt arriving from Beijing, China</li> <li>Date of implementation: not specified</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Country implementing the measure(s) | <p>Germany and UK</p> <ul style="list-style-type: none"> <li>Region protected by the measure: Germany and UK</li> <li>Region restricted by the measure: China and Hong Kong</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

## Goubar 2009 (Continued)

|            |                                                                                                                                                                                                                                                                                                                                                                        |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Outcome(s) | <p>Number of cases detected due to the intervention</p> <ul style="list-style-type: none"> <li>• Outcome 1: number of exported cases from Beijing</li> <li>• Outcome 2: number of exported cases from Hong Kong</li> <li>• Follow-up: 83 days</li> </ul>                                                                                                               |
| Notes      | <p>Col: "None"</p> <p>Funding: "This work was part of the SARS Control project (Effective and acceptable strategies for the control of SARS and new emerging infections in China and Europe), a European Commission project, funded within the Sixth Framework Programme, Thematic priority scientific support to policies, Contract number: SP22-CT-2004-003824)"</p> |

## Gumel 2004

### Study characteristics

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | <p>Mathematical modelling study</p> <ul style="list-style-type: none"> <li>• Description: extended deterministic SEIR model <ul style="list-style-type: none"> <li>* The model estimates transmission dynamics of individuals with six compartments (susceptible (S), asymptomatic (E), quarantined (Q), symptomatic (I), isolated (J) and recovered (R)) further including natural deaths and inflow of susceptibles.</li> <li>* Super-spreading events are not incorporated and homogenous mixing is assumed.</li> </ul> </li> </ul> |
| Disease                             | SARS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Travel-related control measure(s)   | <p>Entry screening at national borders</p> <ul style="list-style-type: none"> <li>• Description: not specified. <ul style="list-style-type: none"> <li>* Intervention that reduces number of infected travellers arriving per day (base scenario: 0.06 travellers per day)</li> <li>* Modelled reduction: 0%-100%</li> </ul> </li> <li>• Date of implementation: not applicable</li> </ul>                                                                                                                                             |
| Country implementing the measure(s) | <p>Toronto, Canada</p> <ul style="list-style-type: none"> <li>• Region protected by the measure: Toronto, Canada</li> <li>• Region restricted by the measure: all other countries</li> </ul>                                                                                                                                                                                                                                                                                                                                           |
| Outcome(s)                          | <p>Number of cases detected due to the intervention</p> <ul style="list-style-type: none"> <li>• Outcome: number of deaths in Toronto</li> <li>• Follow-up: 200 days</li> </ul>                                                                                                                                                                                                                                                                                                                                                        |
| Notes                               | <p>Col: not reported</p> <p>Funding: "This project was supported in part by the Mathematics of Information Technology and Complex Systems (MITACS) and Natural Sciences and Engineering Research Council (NSERC) of Canada, and by the Canada Research Chair Program (T.D. and J.W.)"</p>                                                                                                                                                                                                                                              |

## Hoehl 2020

### Study characteristics

### Travel-related control measures to contain the COVID-19 pandemic: a rapid review (Review)

## Hoehl 2020 (Continued)

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | Observational screening study                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Disease                             | COVID-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Travel-related control measure(s)   | <p>Evacuation flight: exit screening at national borders and quarantine of travellers</p> <ul style="list-style-type: none"> <li>• Entry screening procedures: likely-symptom-focused clinical examination</li> <li>• Exit screening procedures: <ul style="list-style-type: none"> <li>* symptoms of COVID-19</li> <li>* contact with an infected person</li> <li>* accompanying a person belonging to 1 or 2</li> </ul> </li> <li>• Quarantine procedures: quarantine of all passengers tested negative for 14 days</li> <li>• Reference test for entry/exit screening: <ul style="list-style-type: none"> <li>* observation of cases during quarantine (no further details provided),</li> <li>* PCR test for all passengers (once, likely upon arrival)</li> </ul> </li> <li>• Reference test for quarantine observation: <ul style="list-style-type: none"> <li>* PCR test for all passengers (once, likely upon arrival)</li> </ul> </li> <li>• Quarantine procedures: quarantine of all passengers tested negative for 14 days</li> <li>• Quarantine procedures: quarantine of all passengers tested negative for 14 days</li> <li>• Date of implementation: 1 February 2020 (one-time event; evacuation flight)</li> </ul> |
| Country implementing the measure(s) | <p>Frankfurt Airport, Germany</p> <ul style="list-style-type: none"> <li>• Region protected by the measure: Germany</li> <li>• Region restricted by the measure: Hubei Province</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Outcome(s)                          | <p>Cases detected due to the measure</p> <ul style="list-style-type: none"> <li>• Outcome 1: sensitivity</li> <li>• Outcome 2: positive predictive value</li> <li>• Follow-up: 1 day (one time event), with follow-up reference testing</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Notes                               | <p>Col: not reported</p> <p>Funding: not reported</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

## Hsieh 2005

### Study characteristics

|                                     |                                                                                                                                                                                                                                        |
|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | Observational screening study                                                                                                                                                                                                          |
| Disease                             | SARS                                                                                                                                                                                                                                   |
| Travel-related control measure(s)   | <p>Quarantine of travellers crossing national borders</p> <ul style="list-style-type: none"> <li>• Description: quarantine of travellers arriving from SARS-affected areas</li> <li>• Date of implementation: 28 April 2003</li> </ul> |
| Country implementing the measure(s) | <p>Taiwan</p> <ul style="list-style-type: none"> <li>• Region protected by the measure: Taiwan</li> <li>• Region restricted by the measure: SARS-affected areas (not specified)</li> </ul>                                             |
| Outcome(s)                          | Number of cases detected due to the intervention                                                                                                                                                                                       |

**Hsieh 2005** (Continued)

- Outcome: number of true cases detected (among travellers in quarantine)
- Follow-up: 28 April 2003-31 July 2003

|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Notes | <p>Col: not reported</p> <p>Funding: "Y.H.H. (NSC 92-2751-B005-001-Y), C.C.K. (NSC 92-2751-B002-020-Y), and M.S.H. were supported by SARS research grants from the National Science Council of Taiwan"</p> <p>"Y.H.H. would like to thank Mathematics of Information Technology and Complex Systems (MITACS) for their generous financial support for Y.H.H. to attend MITACS SARS meetings at Banff, Alberta, Canada, where several of the above-mentioned discussions took place"</p> |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**Hsieh 2007**
**Study characteristics**

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | <p>Mathematical modelling study</p> <ul style="list-style-type: none"> <li>• Description: extended discrete-time compartmental SIR model <ul style="list-style-type: none"> <li>* The model extends an SIR model with compartments for quarantine status (stratified by case importation), probable cases, hospitalisation and hospital discharge.</li> <li>* It is assumed that the number of imported susceptible people and births during the outbreak are small compared to the total susceptible population (S).</li> </ul> </li> </ul> |
| Disease                             | SARS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Travel-related control measure(s)   | <p>Quarantine of travellers crossing national borders</p> <ul style="list-style-type: none"> <li>• Description: quarantine of travellers arriving at borders from SARS-affected areas</li> <li>• Date of implementation: 28 April 2003</li> </ul>                                                                                                                                                                                                                                                                                            |
| Country implementing the measure(s) | <p>Taiwan</p> <ul style="list-style-type: none"> <li>• Region protected by the measure: Taiwan</li> <li>• Region restricted by the measure: SARS-affected areas (not specified)</li> </ul>                                                                                                                                                                                                                                                                                                                                                   |
| Outcome(s)                          | <p>Cases avoided due to intervention</p> <ul style="list-style-type: none"> <li>• Outcome 1: number of cases in Taiwan seeded by imported cases</li> <li>• Outcome 2: number of deaths in Taiwan resulting from imported cases</li> <li>• Follow-up: 5 months</li> </ul>                                                                                                                                                                                                                                                                     |
| Notes                               | <p>Col: Not reported</p> <p>Funding: "YHH and CCK are supported by National Science Council of Taiwan (Grants NSC 93-2751-B005-001-Y and NSC 93-2751-B002-020-Y). YHH would like to thank MITACS (Canada) for their generous financial support for YHH to attend the MITACS SARS meetings at Banff, Canada, where several of the above-mentioned discussions took place"</p>                                                                                                                                                                 |

**Jernigan 2020**
**Study characteristics**

|              |                               |
|--------------|-------------------------------|
| Study design | Observational screening study |
|--------------|-------------------------------|

**Jernigan 2020** (Continued)

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Disease                             | COVID-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Travel-related control measure(s)   | Exit screening at national borders and quarantine of travellers <ul style="list-style-type: none"> <li>Entry screening procedures: symptom-based arrival screening</li> <li>Quarantine procedures: quarantine of all passengers tested negative for 14 days</li> <li>Reference test for entry screening: <ul style="list-style-type: none"> <li>* monitoring of those under quarantine by CDC and US government staff members (no further details provided)</li> <li>* evaluation of those who developed symptoms (likely PCR, but no details provided)</li> </ul> </li> <li>Reference test for quarantine observation: <ul style="list-style-type: none"> <li>* evaluation of those who developed symptoms (likely PCR, but no details provided);</li> <li>* no reference test for asymptomatic cases</li> </ul> </li> <li>Date of implementation: not specified</li> </ul> |
| Country implementing the measure(s) | USA <ul style="list-style-type: none"> <li>Countries protected by the measures: USA</li> <li>Countries restricted by the measures: China</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Outcome(s)                          | Cases detected due to the measure <ul style="list-style-type: none"> <li>Outcome 1: sensitivity</li> <li>Outcome 2: positive predictive value</li> <li>Follow-up: 1 day (one time event), with follow-up reference testing</li> <li>Outcome 3 (as supporting study): number of positive screening outcomes</li> <li>Outcome 4 (as supporting study): number of true positive screening outcomes detected</li> <li>Follow-up (as supporting study): beginning 23 February 2020</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                     |
| Notes                               | Col: "The author has completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed" <p>Funding: not reported</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

**Koh 2020**
**Study characteristics**

|                                     |                                                                                                                                                                                                                                                                                                                                                          |
|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | Ecological regression model <ul style="list-style-type: none"> <li>Description: model control variables included income level (log of GDP per capita at current USD), population density (log of population per square km), age structure (proportion aged <math>\geq 65</math> years), and air temperature (14-day average after 100th case)</li> </ul> |
| Disease                             | COVID-19                                                                                                                                                                                                                                                                                                                                                 |
| Travel-related control measure(s)   | International travel restrictions/bans <ul style="list-style-type: none"> <li>Description: early and late restriction on international travel as defined by the Oxford COVID-19 Government Response Tracker (OxCGRT)</li> <li>Date of implementation: country-dependent</li> </ul>                                                                       |
| Country implementing the measure(s) | 142 countries <ul style="list-style-type: none"> <li>Region protected by the measure: 142 countries</li> </ul>                                                                                                                                                                                                                                           |

## Koh 2020 (Continued)

|            |                                                                                                                                                                                                          |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|            | <ul style="list-style-type: none"> <li>Region restricted by the measure: country-dependent</li> </ul>                                                                                                    |
| Outcome(s) | Shift in epidemic <ul style="list-style-type: none"> <li>Outcome: change in the effective reproduction number after 100 cases R(T)</li> <li>Follow-up: 14 days</li> </ul>                                |
| Notes      | Col: "All authors have no conflict of interest to declare"<br><br>Funding: "This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors" |

## Linka 2020a

### Study characteristics

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | Mathematical modelling study <ul style="list-style-type: none"> <li>Description: SEIR model combined with mobility network model <ul style="list-style-type: none"> <li>* Per country discretised SEIR model based on a network graph representation of Europe to integrate travel and transmission dynamics and estimate daily increments in each compartment in each country using mobility coefficients.</li> </ul> </li> </ul>                                           |
| Disease                             | COVID-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Travel-related control measure(s)   | Closure of national borders <ul style="list-style-type: none"> <li>Description: the EU closed all its external borders to prevent further spreading of the virus</li> <li>Date of implementation: 17 March 2020</li> <li>The travel-related control measure is operationalised in the model as a reduction in expected mobility</li> </ul>                                                                                                                                   |
| Country implementing the measure(s) | 27 countries of the EU <ul style="list-style-type: none"> <li>Region protected by the measure: 27 countries of the EU</li> <li>Region restricted by the measure: country-dependent</li> </ul>                                                                                                                                                                                                                                                                                |
| Outcome(s)                          | Cases avoided due to intervention <ul style="list-style-type: none"> <li>Outcome 1: proportion of infectious individuals in the population</li> <li>Follow-up: 23 March-20 April 2020</li> </ul> Shift in epidemic development <ul style="list-style-type: none"> <li>Outcome 2: time from introduction of travel restriction until inflection point in R(T)</li> <li>Follow-up: R(T) tracked from introduction of specific travel measure until inflection point</li> </ul> |
| Notes                               | Col: "The authors declare no conflict of interest"<br><br>Funding: "This work was supported by a Stanford Bio-X IIP seed grant to Mathias Peirlinck and Ellen Kuhl and by a DAAD Fellowship to Kevin Linka"                                                                                                                                                                                                                                                                  |

## Linka 2020b

### Study characteristics

## Linka 2020b (Continued)

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | Mathematical modelling study <ul style="list-style-type: none"> <li>Description: SEIR model combined with mobility network model <ul style="list-style-type: none"> <li>* Per country discretised SEIR model based on a network graph representation of Europe to integrate travel and transmission dynamics and estimate daily increments in each compartment in each country using mobility coefficients.</li> </ul> </li> </ul>                                           |
| Disease                             | COVID-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Travel-related control measure(s)   | Closure of national borders <ul style="list-style-type: none"> <li>Description: the EU closed all its external borders to prevent further spreading of the virus</li> <li>Date of implementation: 17 March 2020</li> <li>The travel-related control measure is operationalised in the model as a reduction in expected mobility</li> </ul>                                                                                                                                   |
| Country implementing the measure(s) | 27 countries of the EU <ul style="list-style-type: none"> <li>Region protected by the measure: 27 countries of the EU</li> <li>Region restricted by the measure: country-dependent</li> </ul>                                                                                                                                                                                                                                                                                |
| Outcome(s)                          | Cases avoided due to intervention <ul style="list-style-type: none"> <li>Outcome 1: proportion of infectious individuals in the population</li> <li>Follow-up: 23 March-20 April 2020</li> </ul> Shift in epidemic development <ul style="list-style-type: none"> <li>Outcome 2: time from introduction of travel restriction until inflection point in R(T)</li> <li>Follow-up: R(T) tracked from introduction of specific travel measure until inflection point</li> </ul> |
| Notes                               | Col: "The authors declare no conflict of interest" <p>Funding: "This work was supported by a Stanford Bio-X IIP seed grant to Mathias Peirlinck and Ellen Kuhl and by a DAAD Fellowship to Kevin Linka"</p>                                                                                                                                                                                                                                                                  |

## Lytras 2020

### Study characteristics

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | Observational screening study                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Disease                             | COVID-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Travel-related control measure(s)   | Evacuation flights: entry screening at national borders and quarantine of travellers <ul style="list-style-type: none"> <li>Entry screening procedures: symptom-based arrival screening</li> <li>Quarantine procedures: quarantine of all passengers tested negative for 14 days</li> <li>Reference test for entry/exit screening: <ul style="list-style-type: none"> <li>* PCR-testing of passengers upon arrival</li> <li>* observation of passengers for 14 days (without additional PCRs)</li> </ul> </li> <li>Reference test for quarantine screening: none</li> <li>Date of implementation: 22-25 March 2020</li> </ul> |
| Country implementing the measure(s) | Greece <ul style="list-style-type: none"> <li>Region protected by the measure: Greece</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

## Lytras 2020 (Continued)

- Region restricted by the measure: UK, Spain, Turkey

|            |                                                                                                                                                                                                   |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Outcome(s) | Cases detected due to the measure <ul style="list-style-type: none"> <li>• Outcome 1: sensitivity</li> <li>• Outcome 2: positive predictive value</li> <li>• Follow-up: not applicable</li> </ul> |
| Notes      | Col: "None declared"<br><br>Funding: "No funding was received for this study"                                                                                                                     |

## Mandal 2020

### Study characteristics

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | Mathematical modelling study <ul style="list-style-type: none"> <li>• Description: extended SEIR model <ul style="list-style-type: none"> <li>* A deterministic epidemic is simulated with an SEIR model to inform projections for daily cases introduced at points of entry in the destination country based on a binomial distribution.</li> <li>* Symptomatic and asymptomatic cases are assumed to have different travel probabilities and some proportion of both is detected during entry screening.</li> </ul> </li> </ul> |
| Disease                             | COVID-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Travel-related control measure(s)   | Entry screening at national borders <ul style="list-style-type: none"> <li>• Description: screening of symptomatic passengers arriving from China at ports of entry</li> <li>• Date of implementation: not specified (likely mid-January 2020)</li> </ul>                                                                                                                                                                                                                                                                         |
| Country implementing the measure(s) | India <ul style="list-style-type: none"> <li>• Region protected by the measure: India</li> <li>• Region restricted by the measure: China</li> </ul>                                                                                                                                                                                                                                                                                                                                                                               |
| Outcome(s)                          | Shift in epidemic development <ul style="list-style-type: none"> <li>• Outcome: number of days to reach a prevalence of 1000 cases</li> <li>• Follow-up: not specified</li> </ul>                                                                                                                                                                                                                                                                                                                                                 |
| Notes                               | Col: "None"<br><br>Funding: "None"                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

## Ng 2020

### Study characteristics

|                                   |                                                                                     |
|-----------------------------------|-------------------------------------------------------------------------------------|
| Study design                      | Observational screening study                                                       |
| Disease                           | COVID-19                                                                            |
| Travel-related control measure(s) | Evacuation flight: entry screening at national borders and quarantine of travellers |

## Ng 2020 (Continued)

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                     | <ul style="list-style-type: none"> <li>Entry screening procedures: fever-based arrival screening</li> <li>Exit screening procedures: fever-based departure screening</li> <li>Quarantine procedures: quarantine of all passengers tested negative for 14 days</li> <li>Reference test for entry/exit screening: <ul style="list-style-type: none"> <li>medical assessment of quarantined 3 x/d</li> <li>PCR assessment of those showing symptoms</li> <li>PCR-assay on day 3 and day 6 of quarantine of most of those quarantined</li> </ul> </li> <li>Date of implementation: 30 January 2020</li> </ul> |
| Country implementing the measure(s) | Singapore <ul style="list-style-type: none"> <li>Region protected by the measure: Singapore</li> <li>Region restricted by the measure: China (Wuhan)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Outcome(s)                          | Cases detected due to the measure <ul style="list-style-type: none"> <li>Outcome 1: sensitivity</li> <li>Outcome 2: positive predictive value</li> <li>Follow-up: 1 day (one-time event), with follow-up reference testing</li> </ul>                                                                                                                                                                                                                                                                                                                                                                     |
| Notes                               | Col: not reported<br><br>Funding: "Supported by the following grants from the National Medical Research Council, Ministry of Health, Singapore: Collaborative Solutions Targeting Antimicrobial Resistance Threats in Health Systems (CoSTAR-HS) (NMRC CGAug16C005), NMRC Clinician Scientist Award (MOH-000276), and NMRC Clinician Scientist Individual Research Grant (MOH-CIRG18nov-0006)"                                                                                                                                                                                                            |

## Nishiura 2020

### Study characteristics

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | Observational screening study                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Disease                             | COVID-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Travel-related control measure(s)   | Evacuation flight: entry/exit screening at national borders and quarantine of travellers <ul style="list-style-type: none"> <li>Entry screening procedures: <ul style="list-style-type: none"> <li>likely-symptom-focused clinical examination and</li> <li>RT-PCR of oropharyngeal swab samples</li> </ul> </li> <li>Quarantine procedures: quarantine of all passengers tested negative for 14 days</li> <li>Reference test for entry/exit screening: <ul style="list-style-type: none"> <li>Observation of cases during quarantine</li> <li>PCR test for all those who developed symptoms during quarantine,</li> <li>RT-PCR test of oropharyngeal swab samples on day 1 and</li> <li>at the end of the 14-day quarantine period for all asymptomatic passengers</li> </ul> </li> <li>Reference test for quarantine observation: <ul style="list-style-type: none"> <li>PCR test for all those who developed symptoms during quarantine,</li> <li>RT-PCR test of oropharyngeal swab samples on day 1 and</li> <li>at the end of the 14 day quarantine period for all asymptomatic passengers</li> </ul> </li> <li>Date of implementation: 29-31 January 2020 (evacuation flights)</li> </ul> |
| Country implementing the measure(s) | Canada                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

## Nishiura 2020 (Continued)

- Region protected by the measure: Tokyo, Japan
- Region restricted by the measure: Hubei Province, China

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Outcome(s) | <p>Number of cases detected due to the intervention</p> <ul style="list-style-type: none"> <li>• Outcome 1: sensitivity (symptom screening)</li> <li>• Outcome 2: positive predictive value (symptom screening)</li> <li>• Outcome 3: sensitivity (PCR screening)</li> <li>• Outcome 4: positive predictive value (PCR screening)</li> <li>• Outcome 5: sensitivity (combined symptom and PCR screening)</li> <li>• Outcome 6: positive predictive value (combined symptom and PCR screening)</li> <li>• Follow-up: 29-31 January 2020 (evacuation flights), with follow-up reference testing</li> </ul>                                                                                                                                                                                                 |
| Notes      | <p>Col: "We declare that we have no conflict of interest"</p> <p>Funding: "HN received funding support from the Japan Agency for Medical Research and Development (grant number JP18fk0108050), the Japan Society for the Promotion of Science (JSPS) Grants-in-Aid for Scientific Research (KAKENHI in Japanese abbreviation; grant numbers 17H04701,17H05808,18H04895 and19H01074), and the Japan Science and Technology Agency (JST) Core Research for Evolutional Science and Technology (CREST) program (grant number JPMJCR1413). NML received a graduate study scholarship from the Ministry of Education, Culture, Sports, Science, and Technology, Japan. The funders had no role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript"</p> |

## Odendaal 2020

### Study characteristics

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | <p>Mathematical modelling study</p> <ul style="list-style-type: none"> <li>• Description: unspecified <ul style="list-style-type: none"> <li>* Data-driven approach</li> <li>* The model uses observed data to fit an exponential curve and project the cumulative number of infected into the future.</li> <li>* Asymptomatic infections are assumed to become contagious some time after the moment of infection from exposure and the average person who has been infected will show symptoms after the average incubation period.</li> </ul> </li> </ul> |
| Disease                             | COVID-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Travel-related control measure(s)   | <p>International travel restrictions/bans</p> <ul style="list-style-type: none"> <li>• Description: travel ban from China</li> <li>• Date of implementation: 31 January 2020</li> </ul>                                                                                                                                                                                                                                                                                                                                                                      |
| Country implementing the measure(s) | <p>USA</p> <ul style="list-style-type: none"> <li>• Region protected by the measure: USA</li> <li>• Region restricted by the measure: China</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                       |
| Outcome(s)                          | <p>Shift in epidemic development due to the intervention</p> <ul style="list-style-type: none"> <li>• Outcome: delay of community transmission</li> <li>• Follow-up: 3 months</li> </ul>                                                                                                                                                                                                                                                                                                                                                                     |
| Notes                               | Col: not reported                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

## Odendaal 2020 (Continued)

Funding: not reported

## Pang 2003

### Study characteristics

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | Observational screening study (supporting study)                                                                                                                                                                                                                                                                                                                                               |
| Disease                             | SARS                                                                                                                                                                                                                                                                                                                                                                                           |
| Travel-related control measure(s)   | Entry screening <ul style="list-style-type: none"> <li>Description: entry screening using infrared thermometers and axillary thermometers</li> <li>Date of implementation: late April, 2003</li> </ul>                                                                                                                                                                                         |
| Country implementing the measure(s) | China <ul style="list-style-type: none"> <li>Region protected by the measure: China</li> <li>Region restricted by the measure: not specified (international travellers)</li> </ul>                                                                                                                                                                                                             |
| Outcome(s)                          | Number of cases detected due to the intervention <ul style="list-style-type: none"> <li>Outcome 1: number of positive screening outcomes</li> <li>Outcome 2: number of true positive screening outcomes detected</li> <li>Follow-up: late April-30 June 2003</li> </ul>                                                                                                                        |
| Notes                               | Col: not reported<br><br>Funding: "Supported by the following grants from the National Medical Research Council, Ministry of Health, Singapore: Collaborative Solutions Targeting Antimicrobial Resistance Threats in Health Systems (CoSTAR-HS) (NMRC CGAug16C005), NMRC Clinician Scientist Award (MOH-000276), and NMRC Clinician Scientist Individual Research Grant (MOH-CIRG18nov-0006)" |

## Quilty 2020a

### Study characteristics

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | Mathematical modelling study <ul style="list-style-type: none"> <li>Description: unspecified (microsimulation)               <ul style="list-style-type: none"> <li>* Microsimulation of travellers planning to board a flight with simulated disease histories and different travel durations, screening detection probabilities and proportions of asymptomatic cases.</li> <li>* Condition of infection worsens after some time, barring travellers from flying.</li> </ul> </li> </ul> |
| Disease                             | COVID-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Travel-related control measure(s)   | Entry/exit screening at national borders <ul style="list-style-type: none"> <li>Description: fever screening with thermal image scanners (sensitivity 86%) on departure and arrival</li> <li>Date of implementation: not applicable</li> </ul>                                                                                                                                                                                                                                             |
| Country implementing the measure(s) | Not specified <ul style="list-style-type: none"> <li>Region protected by the measure: not specified</li> </ul>                                                                                                                                                                                                                                                                                                                                                                             |

## Quilty 2020a (Continued)

- Region restricted by the measure: not specified

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Outcome(s) | <p>Number of cases detected due to the intervention</p> <ul style="list-style-type: none"> <li>• Outcome: proportion of infected travellers detected by screening (sensitivity)</li> <li>• Follow-up: not applicable</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Notes      | <p>Col: "None"</p> <p>Funding: "SF and SC are supported by a Sir Henry Dale Fellowship jointly funded by the Wellcome Trust and the Royal Society (Grant number 208812/Z/17/Z). RME acknowledges an HDR UK Innovation Fellowship (Grant number MR/S003975/1). BJQ was funded by the National Institute for Health Research (NIHR) (16/137/109) using UK aid from the UK Government to support global health research. The views expressed in this publication are those of the author(s) and not necessarily those of the NHS, the NIHR or the UK Department of Health and Social Care. CMMID nCoV working group funding statements: Yang Liu (Gates (INV-003174), NIHR (16/137/109)), Charlie Diamond (NIHR (16/137/109)), Sebastian Funk (Wellcome Trust (210758/Z/18/Z)), Amy Gimma (Global Challenges Research Fund (GCRF) for the project "RECAP" managed through RCUK and ESRC (ES/P010873/1)), James D Munday (Wellcome Trust (210758/Z/18/Z)), Hamish Gibbs (NIHR (ITCRZ 03010)), Sam Abbott (Wellcome Trust (210758/Z/18/Z)), Timothy W Russell (Wellcome Trust (206250/Z/17/Z)), Petra Klepac (Gates (INV-003174)), Mark Jit (Gates (INV-003174), NIHR (16/137/109)), Joel Hellewell (Wellcome Trust (210758/Z/18/Z))."</p> |

## Ryu 2020

### Study characteristics

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | <p>Mathematical modelling study</p> <ul style="list-style-type: none"> <li>• Description: extended deterministic SEIR model <ul style="list-style-type: none"> <li>* SEIR model including quarantine compartment and additional pre-infection seeding as influx into the exposed class to estimate daily infection counts over time under quarantine scenarios.</li> <li>* Assumes that there is no ongoing community transmission at the destination and that there is no pre-symptomatic infectiousness.</li> </ul> </li> </ul> |
| Disease                             | COVID-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Travel-related control measure(s)   | <p>Quarantine of travellers crossing national borders</p> <ul style="list-style-type: none"> <li>• Description: all quarantined individuals were confined at home or to the university dormitory as per the current South Korean quarantine program for COVID-19 (the model assessed scenarios with different rates of quarantine compliance: 70%, 80%, 90% or 100%)</li> <li>• Date of implementation: 15 days before and after 1 March 2020</li> </ul>                                                                          |
| Country implementing the measure(s) | <p>South Korea</p> <ul style="list-style-type: none"> <li>• Region protected by the measure: South Korea</li> <li>• Region restricted by the measure: China</li> </ul>                                                                                                                                                                                                                                                                                                                                                            |
| Outcome(s)                          | <p>Cases avoided due to intervention</p> <ul style="list-style-type: none"> <li>• Outcome: total number of infected individuals seeded by arriving students</li> <li>• Follow-up: 180 days</li> </ul>                                                                                                                                                                                                                                                                                                                             |
| Notes                               | <p>Col: "The authors declare no conflict of interest"</p> <p>Funding: "This research received no external funding"</p>                                                                                                                                                                                                                                                                                                                                                                                                            |

## Samaan 2004

### Study characteristics

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | Observational screening study                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Disease                             | ARS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Travel-related control measure(s)   | <p>Multi-level entry screening based on symptoms (e.g. cough, shortness of breath, difficulty breathing), travel history, fever and application of the WHO probable case definition at Australian international airports and seaports</p> <ul style="list-style-type: none"> <li>Description: 3-level screening <ul style="list-style-type: none"> <li>* Level 1: referral of passengers presenting with respiratory symptoms to Australian Quarantine and Inspection Service (AQIS); based on travel history and symptoms, referral of suspected cases to nurses stationed at the airports</li> <li>* Level 2: assessment of clinical symptoms and potential exposure to SARS based on the WHO case definition by nurses</li> <li>* Level 3: referral of suspected cases to Chief Quarantine Officer (CQO) of state or territory hospital for further assessment and management</li> </ul> </li> </ul> |
| Country implementing the measure(s) | <p>Australia</p> <ul style="list-style-type: none"> <li>Country protected by the measures: Australia</li> <li>Countries restricted by the measures: all other countries</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Outcome(s)                          | <p>Cases detected due to the measure</p> <ul style="list-style-type: none"> <li>Outcome 1: sensitivity</li> <li>Outcome 2: positive predictive value</li> <li>Follow-up: ~2 months (5 April and 16 June 2020)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Notes                               | <p>Col: "None identified"</p> <p>Funding: "This research was supported by the Masters of Applied Epidemiology Program at the Australian National University and funded by the Australian Department of Health and Ageing"</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

## Sriwijitalai 2020a

### Study characteristics

|                                     |                                                                                                                                                                                                                                                              |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | Observational screening study (supporting study)                                                                                                                                                                                                             |
| Disease                             | COVID-19                                                                                                                                                                                                                                                     |
| Travel-related control measure(s)   | <p>Entry screening at international airports in Thailand</p> <ul style="list-style-type: none"> <li>Description: active screening through taking body temperature and clinical history</li> <li>Date of implementation: since early December 2019</li> </ul> |
| Country implementing the measure(s) | <p>Canada</p> <ul style="list-style-type: none"> <li>Country protected by the measures: Thailand</li> <li>Countries restricted by the measures: unclear whether screening applies to all arrivals, or only those from China</li> </ul>                       |

## Sriwijitalai 2020a (Continued)

|            |                                                                                                                                                                                                                                                                                   |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Outcome(s) | <p>Number of cases detected due to the intervention</p> <ul style="list-style-type: none"> <li>Outcome 1: number of positive screening outcomes</li> <li>Outcome 2: number of true positive screening outcomes detected</li> <li>Follow-up: December 2019-January 2020</li> </ul> |
| Notes      | <p>Col: "There are no conflicts of interest"</p> <p>Funding: "Nil"</p>                                                                                                                                                                                                            |

## St John 2005

### Study characteristics

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | Observational screening study (supporting study)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Disease                             | SARS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Travel-related control measure(s)   | <p>Entry screening at international airports in Canada</p> <ul style="list-style-type: none"> <li>Description: multistage screening <ul style="list-style-type: none"> <li>* stage 1: health alert notice (HAN)-based self-reporting of symptoms and exposure; quality control checks to check on compliance by those responsible for verifying passenger responses;</li> <li>* stage 2: secondary symptom-based screening of positive respondents in pre-screening; parallel screening with thermal scanners</li> </ul> </li> <li>Date of implementation: screening phase 14 May 2003-5 July 2003; fever scanners introduced: 8 May 2003,</li> </ul> |
| Country implementing the measure(s) | <p>Canada</p> <ul style="list-style-type: none"> <li>Country protected by the measures: Canada</li> <li>Countries restricted by the measures: all other countries</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Outcome(s)                          | <p>Number of cases detected due to the intervention</p> <ul style="list-style-type: none"> <li>Outcome 1: number of positive screening outcomes (HAN Cards)</li> <li>Outcome 2: number of true positive screening outcomes detected (HAN cards)</li> <li>Outcome 3: number of positive screening outcomes (thermal scanners)</li> <li>Outcome 4: number of true positive screening outcomes detected by thermal scanners</li> <li>Follow-Up: ~2 months (14 May 2003-5 July 2003)</li> </ul>                                                                                                                                                           |
| Notes                               | <p>Col: not reported</p> <p>Funding: "All funding for deployed screening measures was provided by the Government of Canada based on policy decisions made by the Department of Health"</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

## Tsuboi 2020

### Study characteristics

|              |                               |
|--------------|-------------------------------|
| Study design | Observational screening study |
| Disease      | COVID-19                      |

**Tsuboi 2020** (Continued)

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Travel-related control measure(s)   | <p>Cruise ship outbreak: entry screening at national borders and quarantine of travellers</p> <ul style="list-style-type: none"> <li>• Entry screening procedures: screening based on symptoms of COVID-19 and being a close contact of someone with symptoms</li> <li>• Quarantine procedures: quarantine on board until first PCR test was conducted (2-23 days). Quarantine for 14 days of all those who tested negative</li> <li>• Reference test: <ul style="list-style-type: none"> <li>* testing of all individuals on board with PCR over a 3-week period after arrival</li> <li>* quarantine and observation on board until first PCR test</li> <li>* quarantine and observation for 14 days after negative PCR test</li> <li>* PCR testing of those under quarantine showing symptoms</li> </ul> </li> <li>• Date of implementation: 5 February 2020-23 February 2020</li> </ul> |
| Country implementing the measure(s) | <p>Diamond Princess cruise ship</p> <ul style="list-style-type: none"> <li>• Country protected by the measures: the countries where the ship lands and the countries to which travellers would return</li> <li>• Country restricted by the measures: not applicable; Diamond Princess cruise ship</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Outcome(s)                          | <p>Cases detected due to the measure</p> <ul style="list-style-type: none"> <li>• Outcome 1: sensitivity</li> <li>• Outcome 2: positive predictive value</li> <li>• Follow-up: 1 day (one-time event), with follow-up reference testing</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Notes                               | <p>Col: not reported</p> <p>Funding: not reported</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

**Utsunomiya 2020**
**Study characteristics**

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | <p>Mathematical modelling study</p> <ul style="list-style-type: none"> <li>• Description: Moving Regression (MR) and Hidden Markov Model (HMM) <ul style="list-style-type: none"> <li>* Data-driven approach.</li> <li>* Framework for the real-time decomposition of infection growth curves into growth rate and acceleration and classification of stages ('lagging', 'exponential', 'deceleration', 'stationary'), which can be used to track intervention effects over time. Assumes that changes in cases per day are solely attributable to intervention.</li> </ul> </li> </ul> |
| Disease                             | COVID-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Travel-related control measure(s)   | <p>International travel restrictions/bans</p> <ul style="list-style-type: none"> <li>• Description: international travel restrictions as defined by the Oxford COVID-19 Government Response Tracker (OxCGRT)</li> <li>• Date of implementation: country-dependent (not specified)</li> </ul>                                                                                                                                                                                                                                                                                            |
| Country implementing the measure(s) | <p>62 countries (unclear how many of which implemented travel-related control measures)</p> <ul style="list-style-type: none"> <li>• Region protected by the measure: 62 countries (unclear how many of which implemented travel-related control measures)</li> <li>• Region restricted by the measure: country-dependent</li> </ul>                                                                                                                                                                                                                                                    |

## Utsunomiya 2020 (Continued)

|            |                                                                                                                                                                                                                                                                                                       |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Outcome(s) | Shift in epidemic <ul style="list-style-type: none"> <li>Outcome: average change in epidemic growth acceleration after intervention implementation</li> <li>Follow-up: not applicable</li> </ul>                                                                                                      |
| Notes      | Col: "The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest"<br><br>Funding: "This study did not receive financial support and was conducted during voluntary social isolation" |

## Wang 2007

### Study characteristics

|                                     |                                                                                                                                                                                                                                |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | Observational screening study                                                                                                                                                                                                  |
| Disease                             | SARS                                                                                                                                                                                                                           |
| Travel-related control measure(s)   | Quarantine of travellers crossing national borders <ul style="list-style-type: none"> <li>Description: quarantine of travellers arriving from SARS-affected areas</li> <li>Date of implementation: 28 April 28 2003</li> </ul> |
| Country implementing the measure(s) | Taiwan <ul style="list-style-type: none"> <li>Region protected by the measure: Taiwan</li> <li>Region restricted by the measure: SARS-affected areas (not specified)</li> </ul>                                                |
| Outcome(s)                          | Number of cases detected due to the intervention <ul style="list-style-type: none"> <li>Outcome: number of true cases detected (among travellers in quarantine)</li> <li>Follow-up: 28 April 2003-31 July 2003</li> </ul>      |
| Notes                               | Col: not reported<br><br>Funding: not reported                                                                                                                                                                                 |

## Wells 2020

### Study characteristics

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design | Mathematical modelling study <ul style="list-style-type: none"> <li>Description: unspecified (custom model based on maximum likelihood methods) <ul style="list-style-type: none"> <li>* Daily probability that an infected person travels abroad is fitted to observed data and the distribution of incubation period is used to predict importation to other countries weighted by international flight data.</li> <li>* Time to the first transmission event was then estimated using the distribution of the serial interval and the incubation period.</li> </ul> </li> </ul> |
| Disease      | COVID-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

## Wells 2020 (Continued)

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Travel-related control measure(s)   | International travel restrictions/bans <ul style="list-style-type: none"> <li>Description: lockdown of Wuhan and 15 other cities in Hubei</li> <li>Date of implementation: 23 January 2020 (Wuhan) and 24 January 2020 (other cities)</li> </ul>                                                                                                                                                                             |
| Country implementing the measure(s) | China <ul style="list-style-type: none"> <li>Region protected by the measure: other countries</li> <li>Region restricted by the measure: China</li> </ul>                                                                                                                                                                                                                                                                    |
| Outcome(s)                          | Cases avoided due to intervention <ul style="list-style-type: none"> <li>Outcome 1: number of exported cases from China</li> <li>Follow-up: 6 December 2019-15 February 2020</li> </ul> Number of cases detected due to the intervention <ul style="list-style-type: none"> <li>Outcome 2: number of cases exported from China detected by airport screening</li> <li>Follow-up: 6 December 2019-15 February 2020</li> </ul> |
| Notes                               | Col: the authors declare no competing interest<br><br>Funding: not reported                                                                                                                                                                                                                                                                                                                                                  |

## Wilder-Smith 2003

### Study characteristics

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | Observational screening study (supporting study)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Disease                             | SARS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Travel-related control measure(s)   | Entry screening at airports, seaports and road entry point <ul style="list-style-type: none"> <li>Description: stepwise implementation of: <ul style="list-style-type: none"> <li>* health alert notices issued to all arriving travellers, visual and later temperature screening of arriving travellers and referral of suspected cases to hospital</li> <li>* health declaration cards required by passengers arriving from affected areas</li> <li>* Thermal scanners at ports of entry and exit</li> </ul> </li> <li>Date of implementation: <ul style="list-style-type: none"> <li>* 30 March 2003: health alert notices</li> <li>* 31 March 2003: visual screening and later replacement by temperature screening</li> <li>* 7 April 2003: health declaration cards</li> <li>* 23 April 2003: thermal scanners</li> </ul> </li> </ul> |
| Country implementing the measure(s) | Singapore <ul style="list-style-type: none"> <li>Country protected by the measures: Singapore</li> <li>Countries restricted by the measures: all other countries</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Outcome(s)                          | Cases detected due to the measure <ul style="list-style-type: none"> <li>Outcome 1: number of positive screening outcomes (false positive + true positive) among air travel passengers</li> <li>Outcome 2: number of true positive screening outcomes (correct positive) among air travel passengers</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

## Wilder-Smith 2003 (Continued)

- Follow-up: ~ 3 months (25 February 2003-31 May 2003)

|       |                                                                                |
|-------|--------------------------------------------------------------------------------|
| Notes | Col: "The authors had no financial or other conflicts of interest to disclose" |
|       | Funding: not reported                                                          |

## Wilson 2020

### Study characteristics

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | Mathematical modelling study <ul style="list-style-type: none"> <li>• - Description: Stochastic SEIR model</li> <li>• Published stochastic SEIR model is used but its application in the context of simulated flights and details on modelling of in-flight transmission as well as outbreak modelling in destination country is not disclosed. Passengers and crew members arrive daily at disease-free destinations from countries with low prevalence. Passengers and crew can be in various stages of infection and cause infections on flight and in New Zealand.</li> </ul> |
| Disease                             | COVID-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Travel-related control measure(s)   | Entry/exit screening at national borders<br>Quarantine of travellers <ul style="list-style-type: none"> <li>• Description: various combinations of <ul style="list-style-type: none"> <li>* symptom-based exit screening</li> <li>* symptom-based entry screening</li> <li>* PCR tests on day 1, day 1 + 8, day 3-12</li> <li>* contact tracing between PCR test</li> <li>* self-reporting of symptoms</li> <li>* quarantine for 7 days or 14 days</li> </ul> </li> <li>• Date of implementation: not applicable</li> </ul>                                                       |
| Country implementing the measure(s) | New Zealand <ul style="list-style-type: none"> <li>• Region protected by the measure: New Zealand (hypothetical disease-free area)</li> <li>• Region restricted by the measure: Australia (hypothetical low-prevalence area)</li> </ul>                                                                                                                                                                                                                                                                                                                                           |
| Outcome(s)                          | Shift in epidemic development due to the intervention <ul style="list-style-type: none"> <li>• Outcome: time to outbreak</li> <li>• Follow-up: not applicable</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                          |
| Notes                               | Col: "The authors have no competing interests"<br><br>Funding: "Professor Wilson is supported by the New Zealand Health Research Council (16/443) and Ministry of Business Innovation and Employment (MBIE) funding of the BODE3 Programme (UOOX1406). Professor Michael Baker is supported by a New Zealand Health Research Council grant for research on COVID-19 (20/1066)"                                                                                                                                                                                                    |

## Yamahata 2020

### Study characteristics

### Travel-related control measures to contain the COVID-19 pandemic: a rapid review (Review)

**Yamahata 2020** (Continued)

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design                        | Observational screening study                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Disease                             | COVID-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Travel-related control measure(s)   | <p>Cruise ship outbreak: entry screening at national borders and quarantine of travellers</p> <ul style="list-style-type: none"> <li>• Entry screening procedures: screening based on symptoms of COVID-19 and being a close contact of someone with symptoms</li> <li>• Quarantine procedures: quarantine on board until first PCR test was conducted (2-23 days). Quarantine for 14 days of all those who tested negative</li> <li>• Reference test: <ul style="list-style-type: none"> <li>* testing of all individuals on board with PCR over a 3-week period after arrival</li> <li>* quarantine and observation on board until first PCR test</li> <li>* quarantine and observation for 14 days after negative PCR test</li> <li>* PCR testing of those under quarantine showing symptoms</li> </ul> </li> <li>• Date of implementation: 5 February 2020-23 February 2020</li> </ul> |
| Country implementing the measure(s) | <p>Diamond Princess cruise ship</p> <ul style="list-style-type: none"> <li>• Country protected by the measures: the countries where the ship lands and the countries to which travellers would return</li> <li>• Country restricted by the measures: not applicable; Diamond Princess cruise ship</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Outcome(s)                          | <p>Cases detected due to the measure</p> <ul style="list-style-type: none"> <li>• Outcome 1: sensitivity</li> <li>• Outcome 2: positive predictive value</li> <li>• Follow-up: 1 day (one-time event), with follow-up reference testing</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Notes                               | <p>Col: "None declared"</p> <p>Funding: "The authors did not receive any funding for this study"</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

**CDC:** Centers for Disease Control and Prevention; **COI:** conflicts of interest; **COVID-19:** coronavirus disease 2019; **EU:** European Union; **MERS:** Middle East respiratory syndrome; **NPI:** non-pharmaceutical intervention; **PCR:** polymerase chain reaction; **R(T):** current reproduction number; **RT-PCR:** reverse transcription polymerase chain reaction; **SARS:** severe acute respiratory syndrome; **SEIR:** susceptible, exposed, infectious, recovered; **WHO:** World Health Organization

**Characteristics of excluded studies** [ordered by study ID]

| Study                              | Reason for exclusion                                                                                              |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| <a href="#">Adiga 2020</a>         | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Aleta 2020</a>         | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Annan 2015</a>         | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Aravindakshan 2020</a> | The study does not provide a specific effect measure for the travel-related control measure                       |
| <a href="#">Barkan 2020</a>        | The study does not assess the impact of a travel-related control measure affecting travel across national borders |

| Study                              | Reason for exclusion                                                                                              |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| <a href="#">Bell 2004</a>          | The study does not assess a primary outcome of relevance                                                          |
| <a href="#">Benkouiten 2013</a>    | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Benkouiten 2014</a>    | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Benkouiten 2015</a>    | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Branas 2020</a>        | The study does not provide a specific effect measure for the travel-related control measure                       |
| <a href="#">Brauer 2008</a>        | The study does not use assess infectious disease of relevance (i.e. SARS, MERS, COVID-19)                         |
| <a href="#">Camitz 2006</a>        | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Channapathi 2020</a>   | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Cowling 2020</a>       | The study does not provide a specific effect measure for the travel-related control measure                       |
| <a href="#">Dandekar 2020</a>      | The study does not provide a specific effect measure for the travel-related control measure                       |
| <a href="#">Dell'Omodarme 2005</a> | The study does not use assess infectious disease of relevance (i.e. SARS, MERS, COVID-19)                         |
| <a href="#">Eksin 2020</a>         | The study does not use assess infectious disease of relevance (i.e. SARS, MERS, COVID-19)                         |
| <a href="#">Erandi 2020</a>        | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Espinoza 2020</a>      | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Fang 2020</a>          | The study does not provide a specific effect measure for the travel-related control measure                       |
| <a href="#">Fouquet 2020</a>       | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Fredj 2020</a>         | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Gardner 2016</a>       | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Gatto 2020</a>         | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Gautret 2013</a>       | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Gautret 2013a</a>      | The study does not assess the impact of a travel-related control measure affecting travel across national borders |

| Study                          | Reason for exclusion                                                                                              |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------|
| <a href="#">Gautret 2014</a>   | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">German 2015</a>    | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Griffiths 2016</a> | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Gunthe 2020</a>    | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Hossain 2020</a>   | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Hosseini 2020</a>  | The study does not provide a specific effect measure for the travel-related control measure                       |
| <a href="#">Hufnagel 2004</a>  | The study does not assess a primary outcome of relevance                                                          |
| <a href="#">Jia 2020</a>       | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Johansson 2011</a> | The study does not use assess infectious disease of relevance (i.e. SARS, MERS, COVID-19)                         |
| <a href="#">Joo 2019</a>       | The study does not assess a primary outcome of relevance                                                          |
| <a href="#">Jungerman 2017</a> | The study does not assess a primary outcome of relevance                                                          |
| <a href="#">Kong 2020</a>      | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Kraemer 2020</a>   | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Lai 2020a</a>      | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Lai 2020b</a>      | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Lai 2020c</a>      | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Lam 2020</a>       | The study does not provide a specific effect measure for the travel-related control measure                       |
| <a href="#">Lau 2004</a>       | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Lee 2020</a>       | The study does not assess a primary outcome of relevance                                                          |
| <a href="#">Liu 2011</a>       | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Liu 2020</a>       | The study does not use assess infectious disease of relevance (i.e. SARS, MERS, COVID-19)                         |

| Study                              | Reason for exclusion                                                                                              |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| <a href="#">Luna 2007</a>          | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Ma 2017</a>            | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Maeno 2016</a>         | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Malmberg 2020</a>      | The study does not use assess infectious disease of relevance (i.e. SARS, MERS, COVID-19)                         |
| <a href="#">Marcelino 2012</a>     | The study does not use assess infectious disease of relevance (i.e. SARS, MERS, COVID-19)                         |
| <a href="#">Myers 2020</a>         | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Pitman 2005</a>        | The study does not provide a specific effect measure for the travel-related control measure                       |
| <a href="#">Pullano 2020</a>       | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Quilty 2020b</a>       | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Ryu 2019</a>           | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Shah 2020</a>          | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Shumway 2020</a>       | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Sriwijitalai 2020b</a> | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Summan 2020</a>        | The study does not assess a primary outcome of relevance                                                          |
| <a href="#">Sun 2013</a>           | The study does not use assess infectious disease of relevance (i.e. SARS, MERS, COVID-19)                         |
| <a href="#">Thomas 2014</a>        | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Yip 2007</a>           | The study does not provide a specific effect measure for the travel-related control measure                       |
| <a href="#">Yuan 2020</a>          | The study does not assess the impact of a travel-related control measure affecting travel across national borders |
| <a href="#">Zhao 2020a</a>         | The study does not provide a specific effect measure for the travel-related control measure                       |
| <a href="#">Zhao 2020b</a>         | The study does not provide a specific effect measure for the travel-related control measure                       |

**COVID-19:** coronavirus disease 2019; **MERS:** Middle East respiratory syndrome; **SARS:** severe acute respiratory syndrome

## ADDITIONAL TABLES

**Table 1. Summary of QUADAS-2 'risk of bias' assessment for screening studies**

| Table 17. Summary of QoRADS 2 Risk of bias assessment for screening studies |          |                         |                |                    |                     |
|-----------------------------------------------------------------------------|----------|-------------------------|----------------|--------------------|---------------------|
| Study ID                                                                    | Disease  | Risk of bias            |                |                    |                     |
|                                                                             |          | D1: Traveller selection | D2: Index test | D3: Reference test | D4: Flow and timing |
| Entry/exit screening                                                        |          |                         |                |                    |                     |
| <a href="#">Arima 2020</a>                                                  | COVID-19 | Low                     | Low            | Low                | Low                 |
| <a href="#">Hoehl 2020</a>                                                  |          | Low                     | Low            | High               | Unclear             |
| <a href="#">Jernigan 2020</a>                                               |          | Low                     | Low            | High               | High                |
| <a href="#">Lytras 2020</a>                                                 |          | Low                     | Unclear        | High               | Low                 |
| <a href="#">Ng 2020</a>                                                     |          | High                    | Low            | High               | Low                 |
| <a href="#">Yamahata 2020</a>                                               |          | Low                     | Unclear        | High               | High                |
| <a href="#">Samaan 2004</a>                                                 | SARS     | Low                     | Low            | Unclear            | High                |
| Combination of entry/exit screening with quarantine and observation         |          |                         |                |                    |                     |
| <a href="#">Arima 2020</a>                                                  | COVID-19 | Low                     | Low            | Low                | High                |
| <a href="#">Hoehl 2020</a>                                                  |          | Low                     | Low            | High               | High                |
| Quarantine of travellers                                                    |          |                         |                |                    |                     |
| <a href="#">Hsieh 2005/Wang 2007</a>                                        | COVID-19 | Unclear                 | Low            | Unclear            | Unclear             |

**Table 2. Summary of ROBINS-I 'risk of bias' assessment for the observational ecological study**

| Study ID                                                                                                                                               | Disease         | Con-<br>founding | Selection<br>bias | Classification of interven-<br>tion | Intended inter-<br>vention | Missing<br>data | Measurement of<br>outcomes | Reported<br>results | Overall |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|------------------|-------------------|-------------------------------------|----------------------------|-----------------|----------------------------|---------------------|---------|
| <a href="#">Koh 2020</a>                                                                                                                               | <b>COVID-19</b> | Serious          | Moderate          | Serious                             | Serious                    | Moderate        | Serious                    | Low                 | Serious |
| <b>COVID-19:</b> coronavirus disease 2019; <b>Low:</b> low risk; of bias; <b>Moderate:</b> moderate risk of bias; <b>Serious:</b> serious risk of bias |                 |                  |                   |                                     |                            |                 |                            |                     |         |

**Table 3. Summary of quality appraisal for modelling studies**

| Study ID                                             | Disease         | Q1          | Q2          | Q3          | Q4          | Q5           | Q6          | Q7           | Q8       | Q9          | Q10         |
|------------------------------------------------------|-----------------|-------------|-------------|-------------|-------------|--------------|-------------|--------------|----------|-------------|-------------|
| <b>Travel restrictions, bans, and border closure</b> |                 |             |             |             |             |              |             |              |          |             |             |
| <a href="#">Adekunle 2020_1</a>                      | <b>COVID-19</b> | Moderate    | Moderate    | No to minor | Moderate    | Reported     | No to minor | Not reported | Moderate | No to minor | Moderate    |
| <a href="#">Anderson 2020</a>                        |                 | No to minor | Moderate    | No to minor | Moderate    | Reported     | No to minor | Not reported | Moderate | Moderate    | No to minor |
| <a href="#">Anzai 2020</a>                           |                 | Moderate    | Major       | No to minor | Major       | Reported     | No to minor | Not reported | Moderate | Moderate    | Moderate    |
| <a href="#">Banholzer 2020</a>                       |                 | No to minor | Major       | No to minor | No to minor | Reported     | No to minor | Not reported | Moderate | No to minor | No to minor |
| <a href="#">Boldog 2020</a>                          |                 | No to minor | No to minor | No to minor | Moderate    | Not reported | Moderate    | Not reported | Moderate | Moderate    | No to minor |
| <a href="#">Chinazzi 2020</a>                        |                 | No to minor | No to minor | No to minor | Moderate    | Reported     | Moderate    | Not reported | Moderate | No to minor | Moderate    |
| <a href="#">Costantino 2020</a>                      |                 | No to minor | Major       | No to minor | Moderate    | Reported     | Moderate    | Not reported | Moderate | No to minor | Moderate    |
| <a href="#">Linka 2020a</a>                          |                 | No to minor | Moderate    | No to minor | Moderate    | Reported     | Moderate    | Not reported | Moderate | Major       | Moderate    |
| <a href="#">Odendaal 2020</a>                        |                 | Moderate    | Major       | No to minor | No to minor | Reported     | Moderate    | Not reported | Moderate | Major       | Moderate    |

**Table 3. Summary of quality appraisal for modelling studies** (Continued)

|                          |           |             |             |             |             |              |             |              |             |             |             |
|--------------------------|-----------|-------------|-------------|-------------|-------------|--------------|-------------|--------------|-------------|-------------|-------------|
| Utsunomiya 2020          |           | No to minor | Moderate    | No to minor | No to minor | Reported     | No to minor | Reported     | No to minor | Major       | No to minor |
| Wells 2020               |           | No to minor | No to minor | No to minor | Moderate    | Reported or  | No to minor | Not reported | Moderate    | No to minor | No to minor |
| Entry/exit screening     |           |             |             |             |             |              |             |              |             |             |             |
| Clifford 2020            | COVID-19  | No to minor | No to minor | No to minor | Major       | Not reported | Moderate    | Not reported | Moderate    | No to minor | No to minor |
| Gostic 2020              |           | No to minor | Moderate    | No to minor | Moderate    | Not reported | Moderate    | Not reported | Moderate    | No to minor | No to minor |
| Mandal 2020a             |           | No to minor | Major       | Moderate    | Major       | Not reported | Moderate    | Not reported | Moderate    | Moderate    | Moderate    |
| Quilty 2020ab            |           | No to minor | Moderate    | No to minor | Major       | Not reported | Moderate    | Not reported | Moderate    | Major       | No to minor |
| Wells 2020               |           | No to minor | No to minor | No to minor | Moderate    | Reported     | No to minor | Not reported | Moderate    | No to minor | No to minor |
| Glass 2006               | SARS/MERS | No to minor | No to minor | Moderate    | No to minor | Not reported | Moderate    | Not reported | Moderate    | No to minor | Moderate    |
| Goubar 2009              |           | No to minor | Moderate    | No to minor | No to minor | Reported     | No to minor | Not reported | Moderate    | Moderate    | Moderate    |
| Gostic 2015              |           | No to minor | Moderate    | Moderate    | Moderate    | Not reported | Moderate    | Not reported | Moderate    | No to minor | No to minor |
| Gumel 2004               |           | No to minor | No to minor | No to minor | No to minor | Reported     | Moderate    | Not reported | Moderate    | Moderate    | Moderate    |
| Wilson 2020              |           | No to minor | Major       | No to minor | Major       | Not reported | Moderate    | Not reported | Moderate    | Major       | Moderate    |
| Quarantine of travellers |           |             |             |             |             |              |             |              |             |             |             |
| Ryu 2020                 | COVID-19  | No to minor | Major       | Moderate    | Major       | Moderate     | Moderate    | Moderate     | Moderate    | Moderate    | Moderate    |

**Table 3. Summary of quality appraisal for modelling studies** (Continued)

|                                                                                                                                                                                                                                                                                                                                                           |      |             |          |             |             |             |          |          |          |             |          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|----------|-------------|-------------|-------------|----------|----------|----------|-------------|----------|
| Hsieh 2007                                                                                                                                                                                                                                                                                                                                                | SARS | No to minor | Moderate | No to minor | No to minor | No to minor | Moderate | Moderate | Moderate | No to minor | Moderate |
| <p><b>COVID-19:</b> coronavirus disease 2019; <b>major:</b> major concerns; <b>MERS:</b> Middle Eastern respiratory syndrome; <b>moderate:</b> moderate concerns; <b>no to minor:</b> no to minor concerns; <b>SARS:</b> severe acute respiratory syndrome</p> <p>Maybe useful for the reader to define Q1-Q10. I can't find definitions in the text.</p> |      |             |          |             |             |             |          |          |          |             |          |

**Table 4. GRADE evidence profile for travel restrictions reducing cross-border travel (COVID-19)**

| Travel restrictions reducing cross-border travel (COVID-19) |                                                                                             |                               |              |               |                               |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                       |
|-------------------------------------------------------------|---------------------------------------------------------------------------------------------|-------------------------------|--------------|---------------|-------------------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Outcome                                                     | Number of studies                                                                           | Risk of bias                  | Indirectness | Inconsistency | Imprecision                   | Publication bias | Summary effect size                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Certainty of evidence |
| <b>Number of imported or exported cases</b>                 | 5 modelling studies (Adekunle 2020; Anzai 2020; Chinazzi 2020; Costantino 2020; Wells 2020) | Serious concerns <sup>a</sup> | No concerns  | No concerns   | Serious concerns <sup>b</sup> | No concerns      | <p><b>Adekunle 2020:</b> the Wuhan lockdown and restrictions on travel from China led to 55 fewer COVID-19 cases imported from China into Australia. The number of imported cases was reduced from 70 (expected) to 15 (observed) (79% reduction).</p> <p><b>Adekunle 2020:</b> restrictions on travel from Iran, South Korea and Italy did not lead to a significant reduction in the number of cases imported from these countries to Australia.</p> <p><b>Anzai 2020:</b> various restrictions of travel from China led to 226 (95% CI 86 to 449) cases not being exported from China to other countries (70% reduction).</p> <p><b>Chinazzi 2020:</b> a large reduction in the number of cases imported from China was initially observed, but by 1 March 2020 the number of cases had rebounded.</p> <p><b>Costantino 2020:</b> a travel ban led to over 100 fewer cases imported from China to Australia, with most of the additional cases having been avoided in the first 6 weeks of the epidemic (80% reduction). Partial relaxation of the ban</p> | Low<br>⊕⊕○○           |

**Table 4. GRADE evidence profile for travel restrictions reducing cross-border travel (COVID-19)** (Continued)

|                                            |                                                                                   |                                        |             |             |                                      |             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                             |
|--------------------------------------------|-----------------------------------------------------------------------------------|----------------------------------------|-------------|-------------|--------------------------------------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
|                                            |                                                                                   |                                        |             |             |                                      |             | led to only slightly fewer imported cases than full relaxation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                             |
|                                            |                                                                                   |                                        |             |             |                                      |             | Wells 2020: the lockdown of Wuhan and the rest of the Hubei Province led to 549 cases not being exported from China to other countries (81% reduction).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                             |
| <b>Number or proportion of (new) cases</b> | 4 modelling studies (Anderson 2020; Banholzer 2020; Costantino 2020; Linka 2020a) | Very serious concerns <sup>a,c</sup>   | No concerns | No concerns | Serious concerns <sup>b</sup>        | No concerns | <p>Anderson 2020: the number of cases was higher for regions with substantial community transmission (e.g. California: 25-100, Sweden: 20-80), and lower for regions with less transmission (e.g. Japan: 1-5, New Zealand: 5-10). A lower contact rate was associated with a substantially lower number of additional cases in all regions.</p> <p>Banholzer 2020: border closures assessed across 12 countries led to a 26% reduction in new cases (95% CI 13% to 37%).</p> <p>Costantino 2020: a full ban on international travel from China followed by full relaxation led to a large reduction in the total number of cases in Australia (less than 300 cases compared to 3000 cases without the ban).</p> <p>Linka 2020a: across almost all countries, the introduction of travel restrictions across the EU led to a decrease in the proportion of infectious individuals.</p> | <p>Very low</p> <p>⊕○○○</p> |
| <b>Number of deaths</b>                    | 1 modelling study (Costantino 2020)                                               | Serious concerns <sup>a</sup>          | No concerns | No concerns | Very serious concerns <sup>b,d</sup> | No concerns | Costantino 2020: a full ban on international travel from China followed by full relaxation led to a large reduction in the total number of deaths in Australia (8 deaths compared to 400 deaths without the travel ban).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <p>Very low</p> <p>⊕○○○</p> |
| <b>Time to outbreak</b>                    | 2 modelling studies (Anzai 2020; Odendaal 2020)                                   | Very serious concerns <sup>a,e,c</sup> | No concerns | No concerns | Serious concerns <sup>b</sup>        | No concerns | <p>Anzai 2020: various restrictions of travel from China to other countries were associated with a delay in time of a major epidemic. With an R0 of 2.2 and 3.7, the delay was less than one day, with an R0 of 1.5, it was 1.25-2.4 days.</p> <p>Odendaal 2020: the early implementation of a ban on travel from China to the USA de-</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <p>Very low</p> <p>⊕○○○</p> |

**Table 4. GRADE evidence profile for travel restrictions reducing cross-border travel (COVID-19)** (Continued)

|                                      |                                               |                                      |                               |             |                                      |             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                     |
|--------------------------------------|-----------------------------------------------|--------------------------------------|-------------------------------|-------------|--------------------------------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|
|                                      |                                               |                                      |                               |             |                                      |             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | layed community transmission in the USA by 26 days. |
| <b>Risk of outbreak</b>              | 2 modelling studies (Anzai 2020; Boldog 2020) | Serious concerns <sup>a</sup>        | Serious concerns <sup>f</sup> | No concerns | Serious concerns <sup>b</sup>        | No concerns | <p>Anzai 2020: various restrictions of travel from China to other countries were associated with reductions in the risk of an outbreak, varying with R0 and the proportion of contacts traced. The largest reduction was 37% with an R0 of 1.5 and 50% of contacts traced. The smallest reduction was 1% with an R0 of 3.7 and 10% of contacts traced.</p> <p>Boldog 2020: assessed the impact of varying degrees of travel restrictions in China.</p> <ul style="list-style-type: none"> <li>Thailand and Korea: restrictions could be effective in preventing an outbreak when the local R is low (e.g. 1.1); when the local R is higher (e.g. 2.2) or when the number of cases in China increases (e.g. 600,000 cumulative cases), a beneficial impact of restrictions becomes increasingly unlikely.</li> <li>USA: even at lower numbers of cases in China (150,000), 25%, 50% and 75% travel restrictions are associated with a risk of a major outbreak of 80%, 65% and 45%, respectively. At higher numbers of cases in China (400,000), 25% and 50% restrictions had no impact, while 75% restrictions were associated with a risk of a major outbreak of approximately 85%.</li> <li>Canada: at lower numbers of cases in China, 25%, 50% and 75% travel restrictions yielded a risk of a major outbreak of 35%, 30% and 15%, respectively; at higher numbers of cases in China these risks were 80%, 70% and 45%, respectively.</li> </ul> | Very low<br>⊕○○○                                    |
| <b>Effective reproduction number</b> | 1 observational ecological study (Koh 2020)   | Very serious concerns <sup>g,h</sup> | No concerns                   | No concerns | Very serious concerns <sup>b,d</sup> | No concerns | <p>Koh 2020: assessed the impact of various travel-related control measures across 142 countries. More stringent measures and earlier implementation were more effective; early and late implementation of total border closures showed the strongest and statistically significant associations. Associations for all</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Very low<br>⊕○○○                                    |

**Table 4. GRADE evidence profile for travel restrictions reducing cross-border travel (COVID-19)** (Continued)

|                                                       |                                     |                               |             |             |                                      |             |                                                                                                                                                                                                                    |                  |
|-------------------------------------------------------|-------------------------------------|-------------------------------|-------------|-------------|--------------------------------------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| <b>Effective reproduction number</b>                  | 1 modelling study (Linka 2020a)     | Serious concerns <sup>c</sup> | No concerns | No concerns | Very serious concerns <sup>b,d</sup> | No concerns | Linka 2020a: after the implementation of the travel restrictions in the EU, countries saw an inflection point in R(T); the duration of time until this inflection point varied, with a mean of 12.6 days           | Very low<br>⊕○○○ |
| <b>Epidemic growth acceleration after the measure</b> | 1 modelling study (Utsunomiya 2020) | Serious concerns <sup>c</sup> | No concerns | No concerns | Serious concerns <sup>d</sup>        | No concerns | Utsunomiya 2020: international travel controls were associated with a substantial decrease in the growth acceleration of the epidemic progression across 62 countries (−6.05% change, $P = 2.31 \times 10^{-5}$ ). | Low<br>⊕⊕○○      |

**CI:** confidence interval; **EU:** European Union; **R0:** basic reproduction number; **R(T):** current reproduction number

**High certainty:** we are very confident that the true effect lies close to that of the estimate of the effect.

**Moderate certainty:** we are moderately confident in the effect estimate; the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.

**Low certainty:** our confidence in the effect estimate is limited; the true effect may be substantially different from the estimate of the effect.

**Very low certainty:** we have very little confidence in the effect estimate; the true effect is likely to be substantially different from the estimate of effect.

<sup>a</sup>Major quality concerns with the appropriateness of the model's structural assumptions.

<sup>b</sup>Insufficient data reported to enable assessment of precision.

<sup>c</sup>Major quality concerns with the lack of assessment of model uncertainty.

<sup>d</sup>Evidence downgraded for precision concerns, because only 1 study contributes to the outcome.

<sup>e</sup>Major quality concerns with the appropriateness of the model input parameters.

<sup>f</sup>No external validation of the model, therefore evidence is downgraded for indirectness.

<sup>g</sup>Concerns with reliability of outcome data.

<sup>h</sup>Potential confounding.

Note: the number of footnotes provided for each rating indicates the number of levels that the evidence was downgraded for in that domain.

**Table 5. GRADE evidence profile for entry/exit screening at national borders with or without quarantine of travellers (COVID-19, SARS, MERS)**

| Entry/exit screening at national borders with or without quarantine of travellers (COVID-19, SARS, MERS) |                   |              |              |               |             |                  |                     |                       |
|----------------------------------------------------------------------------------------------------------|-------------------|--------------|--------------|---------------|-------------|------------------|---------------------|-----------------------|
| Outcome                                                                                                  | Number of studies | Risk of bias | Indirectness | Inconsistency | Imprecision | Publication bias | Summary effect size | Certainty of evidence |



**Table 5. GRADE evidence profile for entry/exit screening at national borders with or without quarantine of travellers (COVID-19, SARS, MERS)** (Continued)  
**Entry/exit screening at national borders with or without quarantine of travellers (COVID-19)**

|                         |                                                               |                                       |                               |                               |             |             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                  |
|-------------------------|---------------------------------------------------------------|---------------------------------------|-------------------------------|-------------------------------|-------------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| <b>Time to outbreak</b> | 3 modelling studies (Clifford 2020; Mandal 2020; Wilson 2020) | Very serious concern <sup>a,b,c</sup> | Serious concerns <sup>d</sup> | Serious concerns <sup>e</sup> | No concerns | No concerns | <p>Clifford 2020: entry and exit screening, alone or combined, and sensitisation to increase awareness and encourage appropriate responses can delay an outbreak in a hypothetical population. Assuming a baseline sensitivity of 86%, at the beginning of the outbreak when very few infected individuals arrive, the measures can delay the outbreak by several days (ranging from 1-8 days). If introduced later, when the number of infected individuals arriving is higher, the measures do little to delay the outbreak (ranging from &lt; 1-1 day).</p> <p>Mandal 2020: screening of symptomatic individuals led to a marginal delay in reaching 1000 cases (2.2-day delay, from 45-47.7 days) in a hypothetical population. At least 75% of asymptomatic individuals need to be screened in order to delay the epidemic significantly.</p> <p>Wilson 2020: screening of travellers arriving from a hypothetical, low-prevalence area (modelled on Australia), combined with other measures, was assessed in a hypothetical disease-free area (modelled on New Zealand). Under the assumption of 1 flight per day (7.1% of normal travel volume), exit screening alone, assuming a 50% sensitivity, delayed an outbreak by 0.5 years, from 1.7 years (0.04 to 6.09) to 2.2 years (0.6 to 8.11). Co-interventions, such as entry screening, quarantine, testing of arriving travellers, in-flight wearing of masks, contact tracing and self-reporting of symptoms led to larger delays of the outbreak. The most effective combination of measures was exit screening, in-flight wearing of masks, entry screening and a 14-day quarantine of all arriving travellers, leading to a 32.4-year delay, to 34.1 years (0.86 to 126).</p> | Very low<br>⊕○○○ |
|-------------------------|---------------------------------------------------------------|---------------------------------------|-------------------------------|-------------------------------|-------------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|

**Table 5. GRADE evidence profile for entry/exit screening at national borders with or without quarantine of travellers (COVID-19, SARS, MERS).** (Continued)

|                                         |                                                                                                                                      |                                      |                               |             |             |             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |
|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|-------------------------------|-------------|-------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| <b>Detection of infected travellers</b> | 3 modelling studies (Gostic 2020; Quilty 2020a; Wells 2020)                                                                          | Serious concerns <sup>b</sup>        | Serious concerns <sup>d</sup> | No concerns | No concerns | No concerns | <p><b>Gostic 2020:</b> with 25% of cases assumed to be subclinical in a hypothetical population, combined entry and exit screening were found to detect 27% (95% CI 10% to 47%) of infected cases. On their own, exit and entry screening would detect 17% (3% to 33%) and 20% (7% to 40%), respectively. As the proportion of subclinical cases increases (worse-case scenario) the proportion of detected cases decreases, while as the subclinical proportion decreases (best-case), the proportion of cases detected increases.</p> <p><b>Quilty 2020a:</b> with sensitivity of 86% for entry and exit screening, and 17% of cases undetectable, thermal scanner-based entry and exit screening, as well as entry screening alone was found to detect 53% (95% CI 35% to 72%) of cases in a hypothetical population; exit screening was comparatively less effective, detecting only 44% (95% CI 33% to 56%) of cases.</p> <p><b>Wells 2020:</b> assuming only 35.7% of symptomatic individuals are detected, an estimated 82 (72 to 95) cases exported from China were contained by screening measures put in place across the world.</p> | Low<br>⊕⊕○○ |
| <b>Proportion of cases detected</b>     | 6 cross-sectional studies with follow-up reference test (Arima 2020; Hoehl 2020; Jernigan 2020; Lytras 2020; Ng 2020; Yamahata 2020) | Very serious concerns <sup>f,g</sup> | Serious concerns <sup>h</sup> | No concerns | No concerns | No concerns | <p><b>Arima 2020:</b> symptom-based, PCR, a combination of symptom-based and PCR entry screening, and symptom-based observation during quarantine was applied to 566 individuals repatriated from Wuhan to Japan (29-31 January 2020), which included 12 cases (prevalence: 2.2%).</p> <p>During <b>symptom-based screening</b>, 63 individuals were screened positive and 4 of these were cases (proportion of cases detected: 33%). During <b>PCR screening</b>, 7 cases were identified as positive (proportion of cases detected: 58%). When applying the <b>combination of symptom-based and PCR screening</b>, 68 screened positive, of whom 9 were identified as cases. Three further cases were</p>                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |

**Table 5. GRADE evidence profile for entry/exit screening at national borders with or without quarantine of travellers (COVID-19, SARS, MERS)** (Continued)

identified through a follow-up PCR, but were missed both by the initial symptom-based screening and the initial PCR. (proportion of cases detected: 75%). During **quarantine with symptom-based observation**, of the 503 out of 566 individuals who were asymptomatic at entry screening, 6 individuals developed symptoms during the quarantine. Of these, 2 had tested positive in the initial PCR, 2 had tested negative in the initial PCR but tested positive in a follow-up PCR, and 2 tested negative in both the initial and the follow-up PCR. One individual tested positive in a follow-up PCR at the end of the quarantine period, but had remained asymptomatic throughout the quarantine. Thus, the combination of entry-screening and quarantine observation identified 11 out of 12 cases (proportion of cases detected: 91%).

[Hoehl 2020](#): symptom and exposure-based pre-departure screening and quarantine using symptom-based observation was applied to 126 individuals evacuated from Hubei, China, to Frankfurt, Germany (1 February 2020), which included 2 cases (prevalence: 1.6%). During the **exit screening**, 11 individuals were screened positive but none of these were cases (proportion of cases detected: 0%). During the **quarantine with symptom-based observation**, 6 passengers developed symptoms, all of whom were tested negative during PCR. While all cases in this study were identified by PCR of asymptomatic cases, 1 of the cases developed symptoms during hospital quarantine, and therefore would have developed symptoms within the 14-day quarantine period. The **combination of entry and entry screening and quarantine with symptom-based observation** would have detected 1 case, would have missed 1, and would have falsely screened 17 individuals as positive (proportion of cases detected: 50%).

**Table 5. GRADE evidence profile for entry/exit screening at national borders with or without quarantine of travellers (COVID-19, SARS, MERS)** (Continued)

|                                                                                    |                                                                                                                 |                                      |                               |             |             |             |                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                      |
|------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|--------------------------------------|-------------------------------|-------------|-------------|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>PPV</b><br><br>(Interpreted in relation to the specific population and context) | 6 cross-sectional studies with follow-up reference test (Arima 2020; Hoehl 2020; Jernigan 2020; Lytras 2020; Ng | Very serious concerns <sup>f,g</sup> | Serious concerns <sup>h</sup> | No concerns | No concerns | No concerns | <b>Arima 2020:</b> symptom-based, PCR, a combination of symptom-based and PCR screening, and quarantine with symptom-based observation was applied to 566 individuals repatriated from Wuhan to Japan (29-31 January 2020), which included 12 cases (prevalence: 2.2%). During <b>symptom-based screening</b> , 63 individuals screened positive, of which only 4 were cases (prevalence: 2.2%; PPV: 6.4%). During <b>PCR screening</b> , 68 screened posi- | Very low<br><br>⊕○○○ |
|------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|--------------------------------------|-------------------------------|-------------|-------------|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|

**Jernigan 2020: symptom-based pre-departure screening** was applied to 808 US citizens evacuated from Hubei, China to the USA (29 January-6 February), which included 3 cases (prevalence: 0.4%). 0 individuals were screened positive (proportion of cases detected: 0%).

**Lytras 2020: symptom-based entry screening** was applied to 783 individuals repatriated from London, UK, Madrid, Spain (20-25 March 2020), and Istanbul, Turkey, to Athens, Greece, which included 40 cases (prevalence: 5.1%). 1 individual was screened positive and this individual was also a case (proportion of cases detected: 2.5%).

**Ng 2020: fever-based exit screening** was applied to 97 individuals evacuated from Wuhan, China to Singapore (31 January 2020); 3 febrile individuals were denied boarding (case status unknown). Fever-based entry screening was applied to the remaining 94 individuals, which included 4 cases (prevalence: 4.3%). 2 individuals were positive and these were also cases (proportion of cases detected: 50%).

**Yamahata 2020: health evaluation-based screening** of all 3711 passengers and crew aboard the Diamond Princess cruise ship (starting 3 February 2020), which included 696 cases (prevalence: 18.8%). 31 individuals screened positive, including 10 cases (proportion of cases detected: 1.4%).

**Table 5. GRADE evidence profile for entry/exit screening at national borders with or without quarantine of travellers (COVID-19, SARS, MERS)** (Continued) [2020; Yamahata 2020](#))

tive, of which 7 were cases. Three further cases were identified through a follow-up PCR, but were missed both by the initial symptom-based screening and the initial PCR (PPV: 10%). The **combination of entry-screening and quarantine observation** identified 11 out of 12 cases (PPV: 16%).

[Hoehl 2020](#): symptom- and exposure-based pre-departure screening was applied to 126 individuals evacuated from Hubei, China, to Frankfurt, Germany (1 February 2020). During the **exit screening** 0 cases were identified in 11 positively screened travellers (PPV: 0%; prevalence: 1.6%). The **combination of symptom-based arrival screening and quarantine with symptom-based observation** would have detected 1 case, would have missed 1, and would have falsely screened 17 individuals as positive (PPV: 5.6%).

[Jernigan 2020](#): **symptom-based pre-departure screening** of 808 US citizens evacuated from Hubei, China to the USA (29 January-6 February 2020) identified 0 cases in 0 individuals screened positive (PPV: not calculable; prevalence: 0.4%).

[Lytras 2020](#): **Symptom-based entry screening** of 783 individuals repatriated from London, UK, Madrid, Spain (20-25 March 2020), and Istanbul, Turkey to Athens, Greece identified 1 case in 1 individual screened positive (PPV: 100%; prevalence: 5.1%).

[Ng 2020](#): **fever-based entry screening** of 94 individuals (3 further individuals were denied boarding due to fever) evacuated from Wuhan, China to Singapore (31 January 2020), identified 2 cases among 2 individuals screened positive (PPV: 100%; prevalence: 4.3%).

[Yamahata 2020](#): **health evaluation-based screening** of all 3711 passengers and crew aboard the Diamond Princess cruise ship (starting 3 February 2020) identified 10 cases

**Table 5. GRADE evidence profile for entry/exit screening at national borders with or without quarantine of travellers (COVID-19, SARS, MERS)** (Continued)

among 31 individuals screened positive, (PPV: 32.3%; prevalence: 18.8%).

| Entry/exit screening at national borders (SARS) |                                               |             |                                      |             |                                      |             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------------------------------------|-----------------------------------------------|-------------|--------------------------------------|-------------|--------------------------------------|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Number of imported cases</b>                 | 1 modelling study (Goubar 2009)               | No concerns | Serious concerns <sup>i</sup>        | No concerns | Serious concerns <sup>j</sup>        | No concerns | <p>Goubar 2009: symptom-based screening, regardless of its hypothetical sensitivity, predicted no reduction in the number of imported cases from Beijing to Frankfurt (ranging from 0.006 to 0.8 total cases) compared to the number of case imported in the absence of screening.</p> <p>Symptom-based screening, regardless of its hypothetical sensitivity, predicted no reduction in the number of imported cases from Hong Kong to Singapore (ranging from 0.45 to 2.7 total cases) compared to the number of cases imported in the absence of screening (ranging from 0.51 to 2.7 total cases).</p> <p>Low</p> <p>⊕⊕○○</p>                                                                                                                                |
| <b>Number of deaths</b>                         | 1 modelling study (Gumel 2004)                | No concerns | Serious concerns <sup>i</sup>        | No concerns | Very serious concerns <sup>j,k</sup> | No concerns | <p>Gumel 2004: a hypothetical perfect thermal scanner-based, entry-screening programme from the beginning of the SARS outbreak in Toronto, when 1 symptomatic and 6 asymptomatic cases had already been introduced, would have led to only a slight reduction in total deaths from 38 to 35 over 200 days.</p> <p>Very low</p> <p>⊕○○○</p>                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Detection of infected travellers</b>         | 2 modelling studies (Glass 2006; Gostic 2015) | No concerns | Very serious concerns <sup>d,i</sup> | No concerns | No concerns                          | No concerns | <p>Glass 2006: border screening with a low sensitivity (13.8%) was shown to detect only 10% (95% CI 3% to 23%) of infected travellers in a hypothetical population. With increasing sensitivity, the proportion of infected travellers detected also increases.</p> <p>Gostic 2015: different screening approaches based on fever or risk profile were applied in a hypothetical population during entry and exit of travellers. Combined fever and risk screening or fever screening alone both at exit and entry in a stable epidemic were the most effective measures, detecting 63% (95% CI 48% to 75%) of cases. Risk screening at entry in a growing epidemic was least effective, detecting 19% (95% CI 10% to 28%) of cases.</p> <p>Low</p> <p>⊕⊕○○</p> |

**Table 5. GRADE evidence profile for entry/exit screening at national borders with or without quarantine of travellers (COVID-19, SARS, MERS)** (Continued)

|                                                                                |                                                                     |                               |                                      |             |                               |             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                  |
|--------------------------------------------------------------------------------|---------------------------------------------------------------------|-------------------------------|--------------------------------------|-------------|-------------------------------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| Proportion of cases detected                                                   | 1 cross-sectional study with follow-up reference test (Samaan 2004) | Serious concerns <sup>l</sup> | Serious concerns <sup>i</sup>        | No concerns | Serious concerns <sup>j</sup> | No concerns | In general, entry screening alone was less effective than entry and exit screening, risk and fever screening was more effective than each individually, and screening was more effective in a stable epidemic compared to a growing epidemic.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Very low<br>⊕○○○ |
| <b>PPV</b><br>(Interpreted in relation to the specific population and context) | 1 cross-sectional study with follow-up reference test (Samaan 2004) | Serious concerns <sup>l</sup> | Serious concerns <sup>i</sup>        | No concerns | Serious concerns <sup>j</sup> | No concerns | Samaan 2004: in a multi-level entry screening programme in Australia, 794 out of 1.84 million travellers screened positive at stage 1 (based on symptoms, travel history and contact to SARS cases), including 0 cases of SARS (5 April-16 June 2003). At stage 2 of the screening (using a WHO probable case definition, also based on symptoms, travel history and contact to SARS cases, applied by nurses), 19 out of 784 screened positive, including 0 cases of SARS. At stage 3 a Chief Quarantine Officer applied the WHO probable case definition, and referred 6 out of 19 patients for further assessment at hospital or home surveillance, including 0 cases of SARS (proportion of cases detected for all stages of the screening programme: 0%; prevalence < 1%). | Very low<br>⊕○○○ |
| <b>Entry/exit screening at national borders (MERS)</b>                         |                                                                     |                               |                                      |             |                               |             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                  |
| Detection of infected travellers and sensitivity                               | 1 modelling study (Gostic 2015)                                     | No concerns                   | Very serious concerns <sup>d,i</sup> | No concerns | Serious concerns <sup>j</sup> | No concerns | Gostic 2015: different screening approaches based on fever or risk profile were applied in a hypothetical population during entry and exit of travellers. Combined fever and risk screening or fever screening alone both at exit and entry in a stable epidemic were the most effective, detecting 45% (95% CI 31% to 62%) of cases.                                                                                                                                                                                                                                                                                                                                                                                                                                           | Very low<br>⊕○○○ |



**Table 5. GRADE evidence profile for entry/exit screening at national borders with or without quarantine of travellers (COVID-19, SARS, MERS)** (Continued)

**CI:** confidence interval; **COVID-19:** coronavirus disease 2019; **EU:** European Union; **MERS:** Middle Eastern respiratory syndrome; **PPV:** positive predictive value; **SARS:** severe acute respiratory syndrome

<sup>a</sup>Major concerns with the appropriateness of the model structural assumptions.

<sup>b</sup>Major concerns with the appropriateness of the model input parameters.

<sup>c</sup>Concerns with the lack of assessment of model uncertainty.

<sup>d</sup>No external validation of the model, therefore evidence is downgraded for indirectness.

<sup>e</sup>Concerns with inconsistency in the body of evidence.

<sup>f</sup>Concerns that true cases may have been missed by the reference test.

<sup>g</sup>Concerns that the reference test was not given to all individuals.

<sup>h</sup>Travellers on evacuation flights comprised most of the studies; these are likely not representative of usual flights.

<sup>i</sup>Indirect evidence as it focuses on SARS.

<sup>j</sup>Evidence downgraded for precision concerns, because only 1 study contributes to the outcome.

<sup>k</sup>Insufficient data reported to enable assessment of precision.

<sup>l</sup>Concerns regarding whether the reference test was applied consistently to all negatively screened individuals.

Note: the number of footnotes provided for each rating indicate the number of levels that the evidence was downgraded for that domain.

**Table 6. Screening procedures and identification of cases**

| Screening procedure                                                                                                                                                                                                                                                                                                                                   | Approach to identify cases                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Study data                                                                                                                                                                                                                                                                                                                                 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Arima 2020</i>                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                            |
| <b>Symptom-based screening:</b><br><br>[1] Symptom-focused clinical examination upon arrival                                                                                                                                                                                                                                                          | [2] Repeated PCR test of oropharyngeal swab samples of all those who were found to be symptomatic upon arrival<br><br>[3] PCR-based testing of all individuals once upon arrival independent of symptoms (oropharyngeal swabs)<br><br>[4] Observation of symptom development during a 14-day quarantine phase and PCR test (oropharyngeal swabs) among those who developed symptoms<br><br>[5] PCR test of all individuals at the end of the 14-day quarantine period (oropharyngeal swabs) | No. of individuals being evaluated (P): 566<br>No. of individuals with positive index test ( $P_{ip}$ ): 63<br>No. of cases with positive index test ( $C_{ip}$ ): 4<br>No. of cases identified in total (C): 12**<br>Cases missed by index test ( $C_{in}$ ): 8<br><br>** PCR-based exit screening results [5] pending for 14 individuals |
| <b>PCR-based screening:</b><br><br>[3] PCR testing of all individuals once upon arrival independent of symptoms (oropharyngeal swabs)                                                                                                                                                                                                                 | [6] Retesting of all who were found to be symptomatic upon arrival whose first PCR-test was negative (PCR, oropharyngeal swab samples)<br><br>[4] Observation of symptom-development during a 14-day quarantine phase and PCR test (oropharyngeal swabs) among those who developed symptoms<br><br>[5] PCR test of all individuals at the end of the 14-day quarantine period (oropharyngeal swabs)                                                                                         | P: 566<br>$P_{ip}$ : 7*<br>$C_{ip}$ : 7*<br>C: 12**<br>$C_{in}$ : 4<br><br>*2 symptomatic individuals had an initial negative PCR test, but were found positive during later retesting [6]<br><br>** PCR-based exit screening results [5] pending for 14 individuals                                                                       |
| <b>Combination of symptom-based and PCR-based screening</b><br><br>[1] Symptom-focused clinical examination upon arrival and [2] Repeated PCR test of oropharyngeal swab samples of all those who were found to be symptomatic upon arrival<br><br>[3] PCR testing of all individuals once upon arrival independent of symptoms (oropharyngeal swabs) | [4] Observation of symptom-development during a 14-day quarantine phase and PCR test (oropharyngeal swabs) among those who developed symptoms<br><br>[5] PCR test of all individuals at the end of the 14-day quarantine period (oropharyngeal swabs)                                                                                                                                                                                                                                       | P: 566<br>$P_{ip}$ : 68 (63 + 5)<br>$C_{ip}$ : 9*<br>C: 12**<br>$C_{in}$ : 3<br><br>*2 symptomatic individuals had an initial negative PCR test, but were found positive in a later retesting [6]<br><br>** PCR-based exit screening results [5] pending for 14 individuals                                                                |
| <b>Quarantine with symptom-based observation :</b><br><br>[1] Symptom-focused clinical examination upon arrival and [2] Repeated PCR test of                                                                                                                                                                                                          | [3] PCR testing of all individuals who were found asymptomatic upon arrival (oropharyngeal swabs)                                                                                                                                                                                                                                                                                                                                                                                           | P: 566<br>$P_{ip}$ : 69 (63 + 6*)<br>$C_{ip}$ : 11<br>C: 12**<br>$C_{in}$ : 1                                                                                                                                                                                                                                                              |

**Table 6. Screening procedures and identification of cases** (Continued)

|                                                                                                                                                                               |                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| oropharyngeal swab samples of all those who were found to be symptomatic upon arrival                                                                                         | [5] PCR test of all individuals at the end of the 14-day quarantine period (oropharyngeal swabs)                                                                                                                             | *among those without symptoms upon arrival, 4 individuals with an initial negative first PCR test developed symptoms, 2 of which were tested positive in a second PCR test; 5 asymptomatic individuals were found positive in the PCR test upon arrival, 2 of which developed symptoms.                                                                                                                                                                                          |
| [4] Observation of symptom development during a 14-day quarantine phase and PCR test (oropharyngeal swabs) among those who developed symptoms                                 |                                                                                                                                                                                                                              | ** PCR-based exit screening results [5] pending for 14 individuals                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Hoehl 2020</b>                                                                                                                                                             |                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Symptom and contact-based exit and entry screening</b>                                                                                                                     | [3] PCR testing of individuals with positive index test (throat swab and sputum)                                                                                                                                             | P: 126<br>P <sub>ip</sub> : 11 (10 + 1)*<br>C <sub>ip</sub> : 0<br>C: 2**<br>C <sub>in</sub> : 2                                                                                                                                                                                                                                                                                                                                                                                 |
| [1] Departure assessment based on (i) the presence of symptoms of COVID-19, (ii) contact with an infected person, or (iii) accompanying a person belonging to (i) or (ii) and | [4] Observation of quarantined individuals with negative index test during a 14-day quarantine period (no further details provided) and [5] PCR of throat swab and sputum of all those who developed symptoms                | *10 individuals were identified upon departure [1] (two based on contact, 6 based on symptoms, 2 based on being an accompanying person); one individual identified based on symptoms upon arrival                                                                                                                                                                                                                                                                                |
| [2] Symptom-based screening upon arrival                                                                                                                                      | [6] PCR test for all passengers (one time, throat swab and sputum, likely upon arrival)                                                                                                                                      | **One individual declined to receive the PCR test [3]                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Combination of symptom and contact-based exit screening, symptom-based entry screening and quarantine with symptom-based observation</b>                                   | [3] PCR testing of individuals with positive index test (throat swab and sputum)                                                                                                                                             | P: 126<br>P <sub>ip</sub> : 12 (10 + 1 + 1)*<br>C <sub>ip</sub> : 1<br>C: 2**<br>C <sub>in</sub> : 1                                                                                                                                                                                                                                                                                                                                                                             |
| [1] Departure assessment based on (i) the presence of symptoms of COVID-19, (ii) contact with an infected person, or (iii) accompanying a person belonging to (i) or (ii) and | [5] PCR of throat swab and sputum of all those who developed symptoms during quarantine                                                                                                                                      | *10 individuals were identified upon departure [1] (two based on contact, 6 based on symptoms, 2 based on being an accompanying person); one individual was identified based on symptoms upon arrival. Two individuals were found to have a positive PCR test, one of which developed symptoms during the quarantine phase and was counted as likely to be detected based on symptoms during quarantine observation. No individuals with a negative PCR test developed symptoms. |
| [2] Symptom-based screening upon arrival                                                                                                                                      | [6] PCR test for all passengers (one time, throat swab and sputum, likely upon arrival)                                                                                                                                      | **One individual declined to receive the PCR test [3]                                                                                                                                                                                                                                                                                                                                                                                                                            |
| [4] Observation of quarantined individuals with negative index test during a 14-day quarantine period (no further details provided)                                           |                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Jernigan 2020</b>                                                                                                                                                          |                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Symptom-based pre-departure screening</b>                                                                                                                                  | [2] Observation of all individuals under a 14-day quarantine by CDC and U.S. government staff members (no further details provided) and [3] evaluation of those who developed symptoms (likely PCR, but no details provided) | P: 808<br>P <sub>ip</sub> : 0<br>C <sub>ip</sub> : 0<br>C: 3<br>C <sub>in</sub> : 3                                                                                                                                                                                                                                                                                                                                                                                              |
| [1] Symptom-based screening (fever/ feverishness, cough, difficulty breathing) upon departure                                                                                 |                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Lytras 2020</b>                                                                                                                                                            |                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

**Table 6. Screening procedures and identification of cases** (Continued)

|                                                                                                                                    |                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Symptom-based entry screening</b>                                                                                               | [2] PCR testing of all individuals upon arrival                                                                                                                                                                          | P: 783<br>P <sub>ip</sub> : 1<br>C <sub>ip</sub> : 1<br>C: 40*<br>C <sub>in</sub> : 39*                                                                                                                                                                                                                                                                                       |
| [1] Symptom-based screening upon arrival                                                                                           |                                                                                                                                                                                                                          | *In total, 40 individuals had a positive PCR test upon arrival [2]; one of which was symptomatic upon arrival and four developed symptoms during the observational period. An additional 36 individuals with a negative initial PCR test developed symptoms during quarantine, but did not receive an additional PCR test. Some of which, could be additional COVID-19 cases. |
| Ng 2020                                                                                                                            |                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Fever-based exit and entry screening</b>                                                                                        | [3] PCR-based testing of those who were found symptomatic upon arrival.                                                                                                                                                  | P: 97/94*<br>P <sub>ip</sub> : 2*<br>C <sub>ip</sub> : 2<br>C: 4**<br>C <sub>in</sub> : 2**                                                                                                                                                                                                                                                                                   |
| [1] Fever-based exit screening upon departure                                                                                      | [4] Medical assessment of those under quarantine (3x daily) and [5] PCR testing of those who developed symptoms under quarantine observation                                                                             | *In total, 97 individuals arrived to board an evacuation flight in Wuhan. Of these, three were found to be febrile [1] and denied boarding. It is unclear if they subsequently received a diagnostic test and, if so, what the outcome of this test was. Two additional individuals were found symptomatic during the screening upon arrival [2].                             |
| [2] Fever-based entry screening upon arrival                                                                                       | [6] PCR testing of most asymptomatic individuals (76/86) on day 3 and of all individuals at the government quarantine facility on day 6.                                                                                 | ** One of the individuals was reported as having an indeterminate result, but was nevertheless transferred to a hospital for quarantine; here this individual is considered a probable case [4].                                                                                                                                                                              |
| Yamahata 2020                                                                                                                      |                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Health evaluation-based screening</b>                                                                                           | [2] PCR testing of all individuals identified through symptom-based screening                                                                                                                                            | P: 3711 (2666 passengers, 1045 crew)<br>P <sub>ip</sub> : 31*<br>C <sub>ip</sub> : 10*<br>C: 696<br>C <sub>in</sub> : 686                                                                                                                                                                                                                                                     |
| [1] Screening based on symptoms of COVID-19 and being a close contact of someone with symptoms (procedure not described in detail) | [3] PCR testing of all asymptomatic individuals on board with PCR over a three-week period after arrival                                                                                                                 | *The 31 individuals identified through health evaluation-based screening included symptomatic individuals and their close contacts [1]. The figure is not further disaggregated; it is unclear how many symptomatic individuals were among the ten with a positive index test.                                                                                                |
|                                                                                                                                    | [4] quarantine and observation of symptoms on board until first PCR test (passengers and crew were provided a thermometer)                                                                                               |                                                                                                                                                                                                                                                                                                                                                                               |
|                                                                                                                                    | [5] quarantine and symptom observation for 14 days after negative PCR test, [6] PCR testing of those under quarantine showing symptoms after an initial negative initial PCR test over a three-week period after arrival |                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Combination of health evaluation-based screening and quarantine with observation</b>                                            | [2] PCR testing of all individuals identified through symptom-based screening                                                                                                                                            | P: n=3711 (2666 passengers, 1045 crew)<br>P <sub>ip</sub> : n=31*+ unclear**                                                                                                                                                                                                                                                                                                  |

**Table 6. Screening procedures and identification of cases** (Continued)

|                                                                                                                                    |                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| [1] Screening based on symptoms of COVID-19 and being a close contact of someone with symptoms (procedure not described in detail) | [3] PCR testing of all asymptomatic individuals on board with PCR over a three-week period after arrival                             | C <sub>ip</sub> : n= 10* + 286***<br>C: n=696<br>C <sub>in</sub> : n=400 to 410****                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| [4] Quarantine and observation of symptoms on board until first PCR test (passengers and crew were provided a thermometer)         | [6] PCR testing of those under quarantine showing symptoms after an initial negative PCR test over a three-week period after arrival | *The 31 individuals identified through health evaluation-based screening included symptomatic individuals and their close contacts [1]. The figure is not further disaggregated; it is unclear how many symptomatic individuals were among the ten with a positive index test.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| [5] Quarantine and symptom observation for 14 days after negative PCR test                                                         |                                                                                                                                      | **It is not reported, how many individuals were symptomatic but tested negative for SARS-CoV-2.<br><br>***Among the 696 individuals with a positive PCR test, 286 were classified as symptomatic. It was not reported, how many of them were tested for having symptoms rather than having been identified as part of the routine testing. 410 individuals were reported as asymptomatic at the time of testing; it is, however, unclear how many of them developed symptoms during the quarantine period and would have been identified by routine screening.<br><br>****It is unclear, how many of the 10 cases among the 31 individuals with a positive index test were symptomatic (rather than being an asymptomatic close contact). Therefore, the range of individuals missed is between 400 and 410. |

Tsuboi 2020

**Combination of fever-based screening and quarantine with observation**

- [1] Hypothetical screening intervention of identifying individuals with fever (> 37.5 °C) 0-2 days after arrival
- [2] Quarantine and observation of symptoms defined as fever (> 37.5 °C) until first PCR test (passengers and crew were provided a thermometer)
- [3] Quarantine and temperature measurement for 14 days after negative PCR test and reporting if individual developed fever (> 37.5 °C)

- [4] PCR test of all febrile (> 37.5 °C) individuals
- [5] PCR testing of all afebrile individuals (< 37.5 °C)
- [6] PCR testing of those under quarantine with fever (> 37.5 °C) after an initial negative PCR test over a three-week period after arrival

P: 3711 (2666 passengers, 1045 crew)  
P<sub>ip</sub>: 403\*  
C<sub>ip</sub>: 223\*\*  
C: 696\*\*  
C<sub>in</sub>: 473\*\*

\*In total, 403 individuals were reported as febrile. Of those, 11 developed symptoms in the 14 days prior to arrival at the harbour. 9 developed symptoms after arrival at the harbour, but before distribution of thermometers and request for self-monitoring. The remaining 203 cases reported symptom development after a self-monitoring phase. The distribution of fever onset for the non-cases is not reported in depth.

\*\*The cases with COVID-19 symptoms other than fever were not included in the study.

**P:** No. of individuals being evaluated; **P<sub>ip</sub>:** No. of individuals with positive index test; **C<sub>ip</sub>:** No. of cases with positive index test; **C:** No. of cases identified in total; **C<sub>in</sub>:** Cases missed by index test

**Table 7. GRADE evidence profile for quarantine of travellers (COVID-19, SARS)**

| Quarantine of travellers (COVID-19, SARS)       |                                                                               |                                      |                                      |                               |                                      |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                       |
|-------------------------------------------------|-------------------------------------------------------------------------------|--------------------------------------|--------------------------------------|-------------------------------|--------------------------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Outcome                                         | Number of studies                                                             | Risk of bias                         | Indirectness                         | Inconsistency                 | Imprecision                          | Publication bias | Summary effect size                                                                                                                                                                                                                                                                                                                                                                                                                                           | Certainty of evidence |
| Quarantine of travellers (COVID-19)             |                                                                               |                                      |                                      |                               |                                      |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                       |
| <b>Number of cases seeded by imported cases</b> | 1 modelling study (Ryu 2020)                                                  | Very serious concerns <sup>a,b</sup> | Serious concerns <sup>c</sup>        | No concerns                   | Very serious concerns <sup>d,e</sup> | No concerns      | Ryu 2020: the number of cases seeded by quarantined students arriving in South Korea from China was generally low, and decreased with increasing levels of compliance (ranging from 277 to 19 cases).                                                                                                                                                                                                                                                         | Very low<br>⊕○○○      |
| Quarantine of travellers (SARS)                 |                                                                               |                                      |                                      |                               |                                      |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                       |
| <b>Number of cases seeded by imported cases</b> | 1 modelling study (Hsieh 2007)                                                | No concerns                          | Very serious concerns <sup>f,c</sup> | No concerns                   | Very serious concerns <sup>d,e</sup> | No concerns      | Hsieh 2007: the isolation of 2 SARS cases from 95,828 screened travellers resulted in 29 fewer cases in Taiwan seeded by imported cases (5% reduction in number of expected cases). If quarantine of arriving travellers had been implemented at the beginning of the outbreak, 17 additional SARS cases would have been quarantined, and as a result 280 cases seeded by imported cases would have been avoided (49% reduction in number of expected cases). | Very low<br>⊕○○○      |
| <b>Number of deaths</b>                         | 1 modelling study (Hsieh 2007)                                                | No concerns                          | Serious concerns <sup>f</sup>        | No concerns                   | Very serious concerns <sup>d,e</sup> | No concerns      | Hsieh 2007: the isolation of 2 SARS cases from 95,828 quarantined travellers resulted in 5 fewer deaths in Taiwan resulting from imported cases (5% reduction in the number of expected deaths). If quarantine of arriving travellers had been implemented at the beginning of the outbreak, 48 SARS deaths would have been avoided (49% reduction in the number of observed deaths).                                                                         | Very low<br>⊕○○○      |
| Proportion of cases detected                    | 2 cross-sectional study with follow-up reference test (Hsieh 2005; Wang 2007) | Serious concerns <sup>g</sup>        | Serious concerns <sup>f</sup>        | Serious concerns <sup>h</sup> | No concerns                          | No concerns      | Hsieh 2005: 95,828 travellers returning to Taiwan from SARS-affected areas were quarantined; no cases were confirmed (proportion of cases detected: not calculable). Conflicting data on the same programme are reported by Wang 2007.                                                                                                                                                                                                                        | Very low<br>⊕○○○      |

**Table 7. GRADE evidence profile for quarantine of travellers (COVID-19, SARS)** *(Continued)*

Wang 2007: out of 95,271 quarantined travellers returning from Tawain, 56 were confirmed cases. Conflicting data on the same programme are reported by Hsieh 2005.

**CI:** confidence interval; **COVID-19:** coronavirus disease 2019; **EU:** European Union; **MERS:** Middle Eastern respiratory syndrome; **PPV:** positive predictive value; **SARS:** severe acute respiratory syndrome

<sup>a</sup>Major quality concerns with the appropriateness of the model structural assumptions.

<sup>b</sup>Major quality concerns with the appropriateness of the model input parameters.

<sup>c</sup>No external validation of the model, therefore evidence is downgraded for indirectness.

<sup>d</sup>Insufficient data reported to enable assessment of precision.

<sup>e</sup>Evidence downgraded for precision concerns, because only 1 study contributes to the outcome.

<sup>f</sup>Indirect evidence as it focuses on SARS.

<sup>g</sup>Concerns that the true cases were missed.

<sup>h</sup>Conflicting data on the same programme.

Note: the number of footnotes provided for each rating indicate the number of levels that the evidence was downgraded for in that domain.

## APPENDICES

### Appendix 1. Review protocol

#### Travel-related control measures to contain the COVID-19 pandemic: a rapid review (protocol)

##### Authors

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##### Background

The first case of the novel coronavirus disease 2019 (COVID-19) was observed in Wuhan (Hubei province of China) in December 2019. Over the following days and weeks, the disease spread further into China and countries of Asia, including Japan, South Korea, and Thailand (WHO, 2020a). Close to mid-March, cases had been reported in over 100 countries across the globe, and on March 11 2020, the World Health Organization (WHO) declared the outbreak a global pandemic (WHO, 2020b)

COVID-19 is caused by SARS-CoV-2 whose characteristics are similar to those of the coronaviruses causing severe acute respiratory syndrome (SARS-CoV-1/SARS) and Middle East Respiratory Syndrome (MERS-CoV/MERS), respectively. However, in comparison with these viruses, SARS-CoV-2 has higher transmissibility and lower pathogenicity (Fani, Teimoori, & Ghafari, 2020).

Considering lack of existing vaccines to prevent and pharmacological interventions to treat COVID-19, a range of non-pharmacological interventions have been put into place by national and sub-national governments to contain and mitigate the spread of the disease. One suite of measures implemented very early during the onset of the COVID-19 pandemic are travel-related control measures. These range from measures, such as border screening to more severe measures, such as complete closure of national borders. Starting from February 2020, most countries and regions in the world have implemented some type of travel-related control measure. As the pandemic develops across the globe, with some countries reporting a beginning second wave of infections (Strzelecki, 2020), it is crucial to understand the effectiveness of these measures to inform decisions on their further (re)implementation, adaptation, relaxation or suspension. This is in line with the International Health Regulations 2005 calling to ground public health decision-making in scientific evidence (WHO, 2005).

Previous reviews have assessed the effectiveness of travel-related control measures, such as international travel bans and entry/exit screening in the context of SARS and MERS epidemics (Errett, Sauer, & Rutkow, 2020; Mouchtouri et al., 2019). In May 2020, WHO requested the review authors to develop an evidence map charting the evidence of various travel-related control measures relevant for containing COVID-19 pandemic. The map identified 122 studies assessing a range of measures undertaken across the globe to address COVID-19, SARS, MERS, and influenza. Studies used methods ranging from simple observational approaches to complex modelling techniques. This map informed the scope of the present rapid review to synthesize evidence on the effectiveness of travel-related control measures in coronavirus outbreaks.

##### Objectives

To inform WHO recommendations and/or national strategies on travel-related control measures to contain the COVID-19 pandemic, this rapid review aims to assess the effectiveness of international travel-related control measures during coronavirus pandemics on infectious disease and screening-related outcomes.

##### Methods

To conduct this rapid review, at certain stages we will employ abridged procedures of systematic reviewing according to the Cochrane standard (Garrity et al., 2020). Specifically, only one review author will conduct data extraction and risk of bias assessment of epidemiological studies and quality assessment of modelling studies. A second review author will check for correctness, and any uncertainties will be discussed with a third review author. To ensure that this does not compromise the methodological rigor of the systematic review, but also to ensure that all stages of the review are conducted consistently and correctly, we will assign these data extraction and risk of bias/quality assessment tasks to experienced Cochrane review authors and consult researchers with modelling expertise to assist with the quality assessment of modelling studies. Furthermore, we will pilot the procedures for each stage, conduct regular team meetings and keep a list of rolling questions that will be updated continuously.

## Criteria for considering studies for this review

### Types of studies

In the context of a global pandemic, evidence to inform decisions must be generated rapidly, meaning that methods traditionally used to evaluate impact, such as the randomized controlled trial (RCT), while possible, may not be considered feasible, appropriate, timely or ethical. To ensure that we capture all relevant study types, we will consider a broad range of empirical studies of any size that provide a quantitative measure of impact, including experimental and quasi-experimental studies, observational studies, and epidemiological and mathematical modelling studies.

#### Experimental and quasi-experimental studies

- Randomized controlled trials (RCTs)
- Interrupted time series (ITS) studies
- Controlled before-after (CBA) studies and difference-in-differences (DiD) studies
- Instrumental variable (IV) studies
- Regression discontinuity (RD) studies

#### Observational studies

- Cohort studies
- Case-control studies

#### Mathematical and epidemiological modelling studies

- Compartmental models (e.g., SEIR-type models comprising multiple compartments, such as S: susceptible, E: exposed, I: infectious, R: recovered)
- Bayesian hierarchical models (i.e. models comprising several sub-models to integrate observed data as well as uncertainty)
- Spatial models (i.e., modelling disease transmission spatially)
- Epidemiological models (e.g., time series models that model the temporal nature of disease transmission using time-series techniques)

This is likely not an exhaustive list of all the relevant experimental, quasi-experimental, observational, mathematical and epidemiological modelling studies, and - independent of the actual study design - studies use a variety of labels. We will consider all studies providing a quantitative measure of impact, regardless of whether they are indicated by one of these labels.

We will consider studies published in journals as well as those published on preprint servers. We will include RCTs that have been registered but not yet published (in a peer-reviewed journal or on a preprint server) as “ongoing studies”.

We will exclude the following types of studies and publications:

- Case reports
- Studies that do not provide a quantitative measure of impact (e.g., studies providing a graphical summary of the development of the number of cases over time in relation to the introduction of control measures, qualitative studies)
- Diagnostic studies (e.g., assessing the sensitivity and specificity of different screening tests)
- Non-empirical studies (e.g., commentaries, editorials, literature reviews not reporting primary empirical data)
- Systematic reviews (although these will be used for backward citation tracking)
- Conference abstracts

### Language

Where possible in the compressed time frame, we will consider studies published in all languages. Within the review team, we can consider studies in Armenian, English, French, German, Italian, and Russian. For studies in other languages, we will use existing networks within WHO and Cochrane to support us with screening and/or translation.

## Types of participants

We will include human populations (without any age restriction) susceptible to human coronavirus diseases, namely SARS-CoV-1/SARS, SARS-CoV-2/COVID-19, and MERS-CoV/MERS. To be eligible, modelling studies must use modelling parameters for disease transmission specified to reflect one of these diseases.

We will exclude studies (i) not targeting human transmission, (ii) concerned with humans at risk of developing other infectious diseases characterized by different transmission properties (e.g., Ebola and viral meningitis, the transmission mode of which is primarily person-to-person rather than airborne), and/or (iii) addressing humans at risk of developing other infectious diseases, for which travel-related control measures do not play a significant role in containing outbreaks (e.g., influenza).

## Types of interventions

We will consider travel-related control measures affecting human travel across national borders. We will consider both introduction/implementation, as well as relaxation of the following measures:

- Closure of national borders to entry and/or exit
- International travel restrictions/bans
  - Denial of entry and/or exit on the basis of nationality, travel history, health status or other characteristics
  - Full or partial suspension of cross-border travel via land and/or air and/or sea
  - Visa requirement or refusal on the basis of nationality, travel history, health status or other characteristics
- Entry/exit screening at national borders
  - Temperature measurement
  - Health questionnaire (e.g., symptoms, travel history, contact tracing)
  - Thermography
  - Physical examination
  - Testing for current or past infection
  - Passive observation
- Quarantine or isolation of travellers crossing national borders
- Any combination of the above measures

We will exclude the following types of interventions:

• Combinations of the above-mentioned travel-related control measures with other measures where studies do *not* provide effect estimates for the travel-related control measures (e.g., studies providing a combined effect estimate for suspension of cross border travel and use of mandatory face masks). Studies, where the effect of travel-related control measures cannot be disentangled from the effect of a broader suite of public health measures, cannot usefully inform WHO recommendations on whether countries should or should not consider travel-related control measures to contain the COVID-19 pandemic (see review objective).

- All interventions not directly related to travel, including a range of containment and mitigation measures (e.g., community-based quarantine, personal protective measures, hygiene measures, bans on mass gatherings and other social-distancing measures)
- All interventions related to movement of animals or goods
- All interventions concerned with human travel across sub-national borders. While sub-national measures can potentially inform national travel-related control measures, these measures are not prioritized by the WHO, and as shown in the previous evidence map, are often impossible to disentangle from other sub-national measures, such as lockdowns, community quarantine or social distancing recommendations.
- Travel warnings or travel advice issued by the World Health Organization or national governments
- Interventions solely concerned with the accuracy of tests rather than their implementation as part of an entry/exit border control measure
- Usual practice (e.g. seasonal changes to travel) or events (e.g. school holidays) affecting travel but not representing travel-related control measures

- Cancellation of events affecting international travel but undertaken as a means to prevent mass gatherings (e.g., Hajj, international sporting events, international trade fairs)

There are two Cochrane rapid reviews that may identify overlapping studies. One published review, which is currently being updated, focuses on quarantine measures, including quarantining travellers crossing national borders. The other review, currently under editorial assessment and soon to be published, focuses on screening measures, including entry/exit screening at national borders. In discussions with Cochrane and WHO, we decided that it would be important for decision-makers to be able to access the evidence on all travel-related control measures in a single review. To address overlap between the present review and the two separately conducted reviews, we will coordinate the synthesis and write-up of our review findings with those of the quarantine and screening reviews to ensure consistency in reporting and interpretation of the overlapping questions and evidence.

### Types of outcomes

Primary outcomes:

We will consider studies assessing any of the following infectious disease transmission and screening-related outcomes:

- Cases avoided due to the intervention: e.g., number, proportion, rate of cases observed or predicted with and without the intervention
- Number of cases detected due to the intervention: e.g., case detection rate (i.e. number of cases detected per 10,000 screened), positive predictive value (i.e. number of cases detected per those identified as high risk)
- Shift in epidemic development due to the intervention: e.g. probability of epidemic, time to/delay in epidemic arrival or peak, size of epidemic peak, change in the effective reproduction number

Secondary outcomes:

We will consider the following secondary outcomes if identified in studies that assessed at least one of the primary outcomes:

- Any other infectious disease transmission outcomes
- Healthcare utilization (e.g. number of cases requiring ICU treatment, time until ICU capacity is reached)
- Resource requirements for implementing the intervention (e.g. costs associated with intervention, additional personnel, number of tests required)
- Any adverse effects (e.g., health, economic, and social outcomes)

We will not consider studies reporting on other outcomes.

### Search methods for identification of studies

The search strategy will be structured around two blocks focusing on (1) COVID-19, SARS and MERS and (2) travel-related control measures. We will conduct the searches in English but will aim to include studies published in any language (see “Language” above). We will adapt the search strategy used in the evidence map for travel-related control measures. An experienced information specialist will adapt and run systematic searches in the following electronic databases up to the last week of June, 2020:

- Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Daily and Versions(R) (1946-present)
- Ovid Embase (1996-present)

We will additionally search the following COVID-19-specific databases:

- Cochrane COVID-19 Register (<https://covid-19.cochrane.org/>), which contain study references from ClinicalTrials.gov, WHO International Clinical Trials Registry Platform (ICTRP), PubMed, medRxiv and other hand-search articles from publishers’ websites.
- WHO COVID-19 Global literature on coronavirus disease (<https://search.bvsalud.org/global-literature-on-novel-coronavirus-2019-ncov/>), which contains primarily research (published AND/OR pre-publication) journal articles from PubMed, Web of Science, Global Index Medicus, Embase. In addition, Lanzhou University submits on a daily basis citations from CNKI as well as a number of Chinese journal publishers.
- CDC COVID-19 Research Articles Downloadable Database (<https://www.cdc.gov/library/researchguides/2019novelcoronavirus/researcharticles.html>) will be searched exclusively for preprints from bioRxiv, medRxiv and SSRN.

Finally, we will screen the reference lists of the existing systematic reviews on travel-related control measures to identify additional eligible studies. See Appendix 1 for the MEDLINE search strategy.

## Data collection and analysis

### Selection of studies

We will develop a standardized title and abstract screening guidance and pilot it among all review authors involved with the screening using the same 100 titles and abstracts. We will discuss and resolve all issues and revise the screening guidance accordingly. One review author will then screen all titles and abstracts. A second review author will screen all excluded abstracts. We will adopt an inclusive approach at this stage, and all unclear studies will be taken forward to the full text screening. Screening all full texts in duplicate, as described below, will ensure that the single screening of titles and abstracts included at this stage will not compromise methodological rigor.

We will conduct a pilot of the full text screening; all review authors involved with full text screening will screen a set of ten studies at the outset of this stage (Garritty et al., 2020). The team will then discuss any open questions or issues, as well as how to harmonize screening across all review authors. Following the pilot, two review authors will screen the remaining studies in duplicate. Any discrepancies between the two review authors will be discussed, and a third review author or the entire author team will be consulted where necessary.

### Data extraction and management

One review author will extract study characteristics and data from all included studies using a data extraction form in Microsoft Excel. All extracted data will be checked by a second review author. The data extraction form will be an extended version of the form used in the previous evidence map. The following categories will be included in the extraction form:

- Study type
- Population, setting and context
- Characteristics of pathogen/disease
- Context of pathogen/disease
- Intervention
- Outcomes and results

We will pilot the data extraction form using five studies meeting the inclusion criteria. Appendix 2 provides the details on the data extraction categories.

Based on our experience with the evidence map on travel related-control measures, we expect key aspects, notably the description of the intervention and the stage of the epidemic at which the intervention was implemented, to be poorly reported in included studies. Therefore, for included studies addressing COVID-19 in which data on the intervention and stage of the pandemic are not well reported, and where applicable (e.g., some modelling studies may not directly relate to a specific country or point in time), we will explore whether searching for and extracting additional data from external sources will enhance our understanding of these aspects. To do so, we will consider data from the following external sources:

- Intervention data: the COVID-19 Country Policy Tracker, offered by the Organisation for Economic Cooperation and Development (OECD), collates and summarizes countries' policy responses to the current pandemic (<https://www.oecd.org/coronavirus/country-policy-tracker/>). ACAPS, an independent information provider, also manages a large database of country-level policy responses (<https://www.acaps.org/covid19-government-measures-dataset>).
- Stage of the pandemic: Daily COVID-19 situation reports published by the WHO summarize the daily number of total and new cases and deaths for all countries, and specify the current stage of the pandemic as "sporadic cases", "clusters of cases" or "community transmission" (<https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports/>).

In cases for which we utilize external sources, we will carefully document the source of the information.

### Assessment of risk of bias in included studies

One review author will rate the risk of bias (RoB) or quality of each included study, depending on the type of study, and a second review author will check these ratings; any questions or uncertainties that arise throughout the process will be discussed between these review authors or among the review team.

Given the broad range of study designs, we will apply multiple tools in assessing RoB of included studies. For any identified experimental studies, we will apply the Cochrane RoB 2 tool (Higgins et al., 2019). For quasi-experimental and observational studies, we will apply ROBINS-I (Sterne et al., 2016). In applying ROBINS-I, important confounding factors that each study would ideally control for should be defined a priori. Based on the body of evidence identified in the recently conducted evidence map, we expect that most non-modelling studies will assess the impact of entry/exit screening at national borders on the number of cases detected. For those studies, we outline two important categories of confounding factors:

- Between-group differences: where multiple groups are assessed (i.e., screened and non-screened), these regard the composition of the two groups with respect to age, sex, socio-economic status and other factors potentially affecting the risk of infection (e.g., occupation, stay in a high-prevalence area);
- Temporal changes: as these studies are longitudinal in nature, changes over time could lead to confounding (i.e., changes to testing practices, training provided to personnel, and changes in implementation of the measures).

No validated tool exists for assessing the RoB of modelling studies, and little consensus exists in the systematic review community about how to best approach the assessment of RoB and/or quality of an individual modelling study. A rapid review of the methodological literature aimed to identify and summarize studies describing criteria for assessing the quality of mathematical studies (Egger et al., 2017). This review identified 20 studies (including Jaime Caro et al., 2014; Philips, Bojke, Sculpher, Claxton, & Golder, 2006) that varied in scope and level of detail regarding the proposed criteria; looking across the identified studies, it suggested that an assessment of the quality of a modelling study should capture the aspects of (i) model structure, (ii) input data, (iii) different dimensions of uncertainty, (iv) transparency, and (v) validation. Following the suggestions by Eggers et al. (2017), we developed a bespoke tool for the assessment of modelling studies and selected single criteria from two studies (Jaime Caro et al., 2014; Philips, Bojke, Sculpher, Claxton, & Golder, 2006). We sought to strike a balance between capturing all five key aspects and feasibility of applying the criteria. The individual criteria we will apply are outlined in Appendix 3. We will report each of the criteria separately, i.e. we will not combine multiple criteria into a summary score. The quality of modelling studies will be assessed by one review author and checked by a second.

### Data synthesis

We will synthesize the findings narratively, graphically, or in tabular form, stratified by intervention type and disease. Drawing on the previous evidence map and the large heterogeneity identified with regard to the setting, population, intervention and other contextual factors, we expect that data will not be sufficiently similar to conduct meta-analyses. Where possible, we will summarize effect estimates graphically using forest plots.

### Subgroup analyses and investigation of heterogeneity

In the absence of meta-analyses, we will not conduct a statistical assessment of heterogeneity, nor will we statistically assess differences between subgroups. We will nevertheless investigate the influence of potentially important sources of heterogeneity on the impact of interventions, focusing on heterogeneity in selected PICO elements and context. We will consider the following sources of heterogeneity:

- Stage of the pandemic during which the intervention was implemented: impact of travel-related control measures are likely different in countries where only few cases have been detected than in countries where community transmission is established;
- Whether a country is an island state or not: the geographical characteristics of the state (i.e., island state vs. countries with land borders) will serve as a proxy measure of the interconnectedness of the countries and explain possible differences in the efficiency in managing and controlling entries/exits at all ports of entry;
- Assumed infectious disease parameters: assumptions used in models may have a large influence on the direction and magnitude of reported results;
- Whether a single travel-related control measure or a package of travel-related control measures were implemented: multiple integrated travel-related interventions may be more effective than single stand-alone interventions.

We will explore heterogeneity narratively; forest plots and/or tables will be stratified according to these specific aspects. This will not allow us to derive conclusions but could point to aspects potentially modifying the effectiveness of different measures.

### Sensitivity analyses

Where a sufficiently homogeneous evidence base is identified, we will conduct sensitivity analyses, excluding experimental, quasi-experimental, or observational studies at high RoB or modelling studies with major quality concerns, to assess whether these studies influence the results. As for the subgroup analyses described above, in the absence of meta-analyses, this assessment will be narrative, not statistical, in nature.

### Assessment of certainty of evidence

We will use the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach to assess the certainty of the primary outcomes. One review author will collate the evidence per primary outcome and suggest initial certainty of evidence ratings. These will then be further deliberated in a team of review authors and a joint decision for certainty of evidence ratings will be made for each primary outcome.

The certainty of evidence is defined in GRADE as the extent to which one can be confident that the true effect of an intervention lies on one side of a specified threshold, or within a chosen range (Hultcrantz et al., 2017). In this rapid review, we will consider “difference from the null” as an important threshold assuming that even the small effect sizes may be relevant for population-level travel-related control measures.

The certainty of evidence rating in GRADE yields four possible levels of evidence: high certainty (i.e., the estimated effect lies close to the true effect), moderate certainty (i.e., the estimated effect is probably close to the true effect), low certainty (i.e., the estimated effect might substantially differ from the true effect), and very low certainty (i.e., the estimated effect is probably substantially different from the true effect).

We will rate bodies of evidence from experimental, observational and modelling studies separately. In GRADE, evidence from RCTs enters the rating as high certainty, as does evidence from observational studies whose risk of bias has been assessed using ROBINS-I (Schunemann et al., 2019). Further to this five domains are used to further downgrade evidence, including *study limitations*, *inconsistency*, *indirectness*, *imprecision* and *publication bias*, and three domains are used to upgrade evidence, including *plausible confounding*, *large estimates of effect*, and *dose-response relationship*. These domains apply to assessment of evidence from all types of studies, including modelling studies.

To rate certainty of evidence from modelling studies, we will use the recent guidance developed by the GRADE Working Group (Brozek et al.). Evidence from modelling studies also starts the assessment as high certainty, and all the GRADE domains described above are used to assess certainty of model outputs.

Disclaimer: This rapid review is being commissioned and paid for by the World Health Organization (WHO). The authors alone are responsible for the views expressed in this protocol and they do not necessarily represent the views, decisions or policies of WHO.

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Mouchtouri, V. A., Christoforidou, E. P., An der Heiden, M., Menel Lemos, C., Fanos, M., Rexroth, U., . . . Hadjichristodoulou, C. (2019). Exit and Entry Screening Practices for Infectious Diseases among Travelers at Points of Entry: Looking for Evidence on Public Health Impact. *International journal of environmental research and public health*, 16(23), 4638-4638.

Nussbaumer-Streit, B., Mayr, V., Dobrescu, A. I., Chapman, A., Persad, E., Klerings, I., . . . Gartlehner, G. (2020). Quarantine alone or in combination with other public health measures to control COVID-19: a rapid review. *Cochrane Database of Systematic Reviews*(4).

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WHO. (2020b). Novel Coronavirus (2019-nCoV) Situation Report - 51. World Health Organization.

### Protocol Appendix 1. Search Strategy

**Database:** Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Daily and Versions(R) 1946 to June 25, 2020

**Date search conducted:** June 26, 2020

#### Strategy:

1 exp Coronavirus/ (18064)

2 Coronavirus Infections/ (12378)

3 COVID-19.rs. (7963)

4 severe acute respiratory syndrome coronavirus 2.os. (6648)

5 (2019 nCoV or 2019nCoV or 2019-novel CoV).ti,ab,kf. (891)

6 (Coronavir\* or corona virus\* or Middle East Respiratory Syndrome\* or MERS or Severe Acute Respiratory Syndrome\* or SARS\*).ti,ab,kf. (35015)

7 COVID 19.mp. (25238)

8 (COVID19 or COVID 2019).ti,ab,kf. (437)

9 (nCov 2019 or nCov 19).ti,ab,kf. (55)

10 or/1-9 [Set 1: Coronaviruses] (51693)

11 Air Travel/ (366)

12 Travel/ (24964)

13 (border? adj3 (clos\* or restrict\* or control\* or measure?)).ab,kf. (1046)

14 ((isolat\* or quarantin\*) adj6 (exposed or suspected or travel\* or airport? or border?)).ti,ab,kf. (7939)

15 ((mobility or movement\*) adj2 (reduc\* or restrict\*)).ti,ab,kf. (9614)

16 (travel\* or border?).ti. (26180)

17 (travel adj4 (measure? or intervention? or NPI?)).ab,kf. (424)

18 (travel\* adj3 (restrict\* or reduc\* or control\* or limit\* or lockdown? or ban\*)).ab,kf. (1545)

19 ((questionnaire\* or screen\* or surveil\*) adj4 (traveller? or entr\* or exit or border? or airport?)).ti,ab,kf. (1840)

20 visa?.ti,ab,kf. (2086)

21 or/11-20 [Set 2: Travel measures] (64508)

22 and/10,21 [Sets 1 & 2] (945)

23 limit 22 to "humans only (removes records about animals)" (925)

24 remove duplicates from 23 (916)

### Protocol Appendix 2. Categories in the data extraction form

**NOTE: aspects in bold will be primarily relevant for modelling studies.**

#### Study information:

- Study ID
- Study title
- Study source (i.e., journal, report, preprint publication)
- Date of submission
- Date of publication

Study type:

- Study type (e.g., experimental, quasi-experimental, observational, modelling)
- Verbal summary of study type (e.g., stochastic discrete event simulation model)
- Comments

Population, setting, and context:

- Country in which travel-related control measure is implemented
- Region protected by travel-related control measure
- Region restricted by travel-related control measure
- Short description of population studied (e.g., international travellers including flight passenger and crew members arriving between 27 April and 22 June 2009)
- Comments

Characteristics of pathogen/disease:

- Disease (i.e., SARS, MERS, COVID-19)
- **Incubation period**
- **Latent period**
- **Infectiousness of symptomatic persons**
- **Infectiousness of asymptomatic persons**
- Comments

Context of pathogen/disease transmission:

- Stage of pandemic in the protected and restricted regions during which the intervention was implemented (i.e., no cases, sporadic cases, clusters of cases, and community transmission)
  - \* Supporting information for the categorization of the stage of pandemic in the protected and restricted regions (e.g., date of notification of first case, current number of cases, established community spread)
- **Reproduction number: (R0) and R(t) for the region protected by the intervention**

Intervention:

- Broad measure category (i.e., closure of national borders to entry/exit, international travel restrictions/bans, entry/exit screening at national borders, quarantine or isolation of travelers crossing national borders)
- Verbal summary of specific travel-related measure(s) (e.g., all arriving passengers were provided with a symptom questionnaire)
- Date(s) of implementation of the travel-related control measure(s)
- Any reported exceptions to the measure (e.g., certain individuals being excluded or fast-tracked in airport screening because of nationality, occupation, country of origin)
- **Representation of the intervention in the model (e.g., 100% travel reduction)**
- Comments

Primary outcomes (repeated for each primary outcome):

- Outcome category (i.e., cases avoided due to the intervention, number of cases detected due to the intervention, shift in epidemic development due to the intervention)
- Description of outcome
- Length of follow-up
- Estimate related to the impact of the travel-related control measure
- Narrative summary of overall impact of travel-related control measure
- **Additional analysis used to quantify the range of potential effects for this outcome**
- Comments

Secondary outcomes(repeated for each secondary outcome):

- Description of any secondary (non-quantitative) outcomes (i.e., any other infectious disease transmission outcomes, healthcare utilization outcomes, resource requirements for implementing the intervention, and any adverse effects)
- Narrative results of secondary outcomes
- Comments

[External sources] Stage of pandemic in protected and restricted regions during which the intervention was implemented (i.e., no cases, sporadic cases, clusters of cases, and community transmission) – for each aspect extracted the exact source will be documented

[External sources] Intervention – for each aspect extracted the exact source will be documented

- Verbal summary of specific travel-related measure(s) (e.g., all arriving passengers were provided with a symptom questionnaire)
- Date(s) of implementation of the travel-related control measure(s)
- Any reported exceptions to the measure (e.g., certain individuals being excluded or fast-tracked in airport screening because of nationality, occupation, country of origin)

### Protocol Appendix 3. Criteria used for assessing the quality of individual modelling studies

| Aspect                              | Source              | Questions                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Model structure                     | Philips et al. 2006 | 1. Are the structural assumptions transparent and justified?<br><br>2. Are the structural assumptions reasonable given the overall objective, perspective and scope of the model?                                                                                                                                           |
| Input data                          | Caro et al. 2014    | 3. All things considered, do you agree with the values used for the inputs?                                                                                                                                                                                                                                                 |
| Validation (external)               | Caro et al. 2014    | 4. Has the model been shown to accurately reproduce what was observed in the data used to create the model?<br><br>5. Has the model been shown to accurately estimate what actually happened in one or more separate studies?<br><br>6. Has the model been shown to accurately forecast what eventually happens in reality? |
| Validation (internal)               | Caro et al. 2014    | 7. Have the process of internal verification and its results been documented in detail?<br><br>8. Has the testing been performed systematically?<br><br>9. Does the testing indicate that all the equations are consistent with their data sources?                                                                         |
| Different dimensions of uncertainty | Caro et al. 2014    | 10. Was there an adequate assessment of the effects of uncertainty?                                                                                                                                                                                                                                                         |
| Transparency                        | Caro et al. 2014    | 11. Was technical documentation, in sufficient detail to allow (potentially) for replication, made available openly or under agreements that protect intellectual property?                                                                                                                                                 |

### Appendix 2. List of systematic reviews considered for backward citation searches

1. Bitar D, Goubar A, Desenclos JC (2009). International travels and fever screening during epidemics: a literature review on the effectiveness and potential use of non-contact infrared thermometers. *Eurosurveillance*, 14(6), 854-858. Retrieved from [europepmc.org/abstract/MED/19215720](http://europepmc.org/abstract/MED/19215720). (Accession No. 19215720)
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11. Viswanathan, M., Effectiveness and accuracy of universal screening for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2): a systematic review. Under review.

### Appendix 3. Search strategy

#### Search sources

**Database:** Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Daily and Versions(R) 1946 to 25 June 2020

**Date search conducted:** 26 June 2020

#### Strategy:

- 1 exp Coronavirus/ (18064)
- 2 Coronavirus Infections/ (12378)
- 3 COVID-19.rs. (7963)
- 4 severe acute respiratory syndrome coronavirus 2.os. (6648)
- 5 (2019 nCoV or 2019nCoV or 2019-novel CoV).ti,ab,kf. (891)
- 6 (Coronavir\* or corona virus\* or Middle East Respiratory Syndrome\* or MERS or Severe Acute Respiratory Syndrome\* or SARS\*).ti,ab,kf. (35015)
- 7 COVID 19.mp. (25238)
- 8 (COVID19 or COVID 2019).ti,ab,kf. (437)
- 9 (nCov 2019 or nCov 19).ti,ab,kf. (55)
- 10 or/1-9 [Set 1: Coronaviruses] (51693)
- 11 Air Travel/ (366)
- 12 Travel/ (24964)
- 13 (border? adj3 (clos\* or restrict\* or control\* or measure?)).ab,kf. (1046)
- 14 ((isolat\* or quarantin\*) adj6 (exposed or suspected or travel\* or airport? or border?)).ti,ab,kf. (7939)
- 15 ((mobility or movement\*) adj2 (reduc\* or restrict\*)).ti,ab,kf. (9614)
- 16 ((questionnaire\* or screen\* or surveil\*) adj4 (traveller? or entr\* or exit or border? or airport?)).ti,ab,kf. (1840)

- 17 (travel\* or border?).ti. (26180)
- 18 (travel adj4 (measure? or intervention? or NPI?)).ab,kf. (424)
- 19 (travel\* adj3 (restrict\* or reduc\* or control\* or limit\* or lockdown? or ban\*)).ab,kf. (1545)
- 20 visa?.ti,ab,kf. (2086)
- 21 or/11-20 [Set 2: Travel measures] (64508)
- 22 and/10,21 [Sets 1 & 2] (945)
- 23 limit 22 to "humans only (removes records about animals)" (925)
- 24 remove duplicates from 23 (916)

**Database:** Ovid Embase 1996 to 2020 Week 25

**Date search conducted:** 26 June 2020

**Strategy:**

- 1 coronaviridae/ (942)
- 2 exp coronavirinae/ (14305)
- 3 exp coronavirus infection/ (14690)
- 4 (2019 nCoV or 2019nCoV or 2019-novel CoV).ti,ab,kw. (771)
- 5 (Coronavir\* or corona virus\* or Middle East Respiratory Syndrome\* or MERS or Severe Acute Respiratory Syndrome\* or SARS\*).ti,ab,kw. (32753)
- 6 COVID 19.af. (21139)
- 7 (COVID19 or COVID 2019).ti,ab,kw. (359)
- 8 (nCov 2019 or nCov 19).ti,ab,kw. (25)
- 9 or/1-8 [Set 1: Coronaviruses] (51062)
- 10 air transportation/ (46)
- 11 aviation/ (5174)
- 12 travel/ (40603)
- 13 (border? adj3 (clos\* or restrict\* or control\* or measure?)).ab,kw. (991)
- 14 ((isolat\* or quarantin\*) adj6 (exposed or suspected or travel\* or airport? or border?)).ti,ab,kw. (7011)
- 15 ((mobility or movement\*) adj2 (reduc\* or restrict\*)).ti,ab,kw. (11153)
- 16 ((questionnaire\* or screen\* or surveil\*) adj4 (traveller? or entr\* or exit or border? or airport?)).ti,ab,kw. (2322)
- 17 (travel\* or border?).ti. (21481)
- 18 (travel adj4 (measure? or intervention? or NPI?)).ab,kw. (468)
- 19 (travel\* adj3 (restrict\* or reduc\* or control\* or limit\* or lockdown? or ban\*)).ab,kw. (1841)
- 20 visa?.ti,ab,kw. (2247)
- 21 or/10-20 [Set 2: Travel measures] (80769)
- 22 and/9,21 [Sets 1 & 2] (1320)
- 23 (animal experiment/ or exp animal/) not exp human/ (3152639)

24 22 not 23 (1297)

25 conference abstract.pt. (3813218)

26 24 not 25 (1234)

27 remove duplicates from 26 (1222)

**Database:** Cochrane COVID-19 Study Register

**URL:** [covid-19.cochrane.org](https://covid-19.cochrane.org) (searched via the Cochrane Register of Studies: [crsweb.cochrane.org](https://crsweb.cochrane.org))

**Date search conducted:** 26 June 2020

**Strategy:**

#1. (border\* OR travel\*):TI (45)

#2. (border\* ADJ3 (clos\* or restrict\* or control\* or measure\*)):TI,AB (13)

#3. ((isolat\* or quarantin\*) AND (exposed or suspected or travel\* or airport\* or border\*)):TI,AB (225)

#4. ((mobility or movement\*) ADJ2 (reduc\* or restrict\*)):TI,AB (29)

#5. ((questionnaire\* or screen\* or surveil\*) AND (traveller\* or entr\* or exit or border\* or airport\*)):TI,AB (51)

#6. (travel ADJ4 (measure\* or intervention\* or NPI\*)):TI,AB (17)

#7. (travel\* ADJ3 (restrict\* or reduc\* or control\* or limit\* or lockdown\* or ban\*)):TI,AB (63)

#8. visa\*:TI,AB (0)

#9. #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 (353)

**Database:** WHO COVID-19 Global literature on coronavirus disease

**URL:** [search.bvsalud.org/global-literature-on-novel-coronavirus-2019-ncov](https://search.bvsalud.org/global-literature-on-novel-coronavirus-2019-ncov)

**Date search conducted:** 26 June 2020

**Strategy:**

(ti:(border OR borders OR travel\*)) OR (tw:(border\* AND (clos\* OR restrict\* OR control\* OR measure\*))) OR (tw:((isolat\* OR quarantin\*) AND (exposed OR suspected OR travel\* OR airport\* OR border\*))) OR (tw:((mobility OR movement\*) AND (reduc\* OR restrict\*) AND travel\*)) OR (tw:((questionnaire\* OR screen\* OR surveil\*) AND (traveller\* OR entr\* OR exit OR border\* OR airport\*))) OR (tw:(travel AND (measure\* OR intervention\* OR NPI\*))) OR (tw:(travel\* AND (restrict\* OR reduc\* OR control\* OR limit\* OR lockdown\* OR ban\*))) OR (tw:(visa OR visas)) (1146)

**Source:** CDC COVID-19 Research Articles Downloadable Database, current to 25 June 2020

**Subset searched via EndNote:** 6452 preprints from bioRxiv (n = 1058), medRxiv (n = 4344) and SSRN (n = 1050)

**URL:** [www.cdc.gov/library/researchguides/2019novelcoronavirus/researcharticles.html](https://www.cdc.gov/library/researchguides/2019novelcoronavirus/researcharticles.html)

**Date search conducted:** 26 June 2020

**Strategy:**

1. Title Contains "border", Or Title Contains "travel" (35)

2. Any field Contains "border", AND Any field Contains "clos" (14)

3. Any field Contains "border", AND Any field Contains "restrict" (10)

4. Any field Contains "border", AND Any field Contains "control" (23)

5. Any field Contains "border", AND Any field Contains "measure" (23)

6. Any field Contains "isolat", AND Any field Contains "travel" (39)

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7. Any field Contains "isolat", AND Any field Contains "airport" (3)
8. Any field Contains "isolat", AND Any field Contains "border" (7)
9. Any field Contains "quarantin", AND Any field Contains "travel" (33)
10. Any field Contains "quarantin", AND Any field Contains "airport" (1)
11. Any field Contains "quarantin", AND Any field Contains "border" (7)
12. Any field Contains "mobility", AND Any field Contains "reduc", AND Any field Contains "travel" (16)
13. Any field Contains "mobility", AND Any field Contains "restrict", AND Any field Contains "travel" (20)
14. Any field Contains "movement", AND Any field Contains "reduc", AND Any field Contains "travel" (12)
15. Any field Contains "movement", AND Any field Contains "restrict", AND Any field Contains "travel" (13)
16. Any field Contains "questionnaire", AND Any field Contains "airport" (1)
17. Any field Contains "questionnaire", AND Any field Contains "border" (1)
18. Any field Contains "questionnaire", AND Any field Contains "entr" (16)
19. Any field Contains "questionnaire", AND Any field Contains "exit" (2)
20. Any field Contains "screen", AND Any field Contains "airport" (1)
21. Any field Contains "screen", AND Any field Contains "border" (4)
22. Any field Contains "screen", AND Any field Contains "traveller" (6)
23. Any field Contains "screen", AND Any field Contains "exit" (9)
24. Any field Contains "surveil", AND Any field Contains "airport" (5)
25. Any field Contains "surveil", AND Any field Contains "border" (2)
26. Any field Contains "surveil", AND Any field Contains "traveller" (1)
27. Any field Contains "travel", AND Any field Contains "measure" (106)
28. Any field Contains "travel", AND Any field Contains "intervention" (222)
29. Any field Contains "travel", AND Any field Contains "restrict" (70)
30. Any field Contains "travel", AND Any field Contains "reduc" (72)
31. Any field Contains "travel", AND Any field Contains "control" (96)
32. Any field Contains "travel", AND Any field Contains "limit" (40)
33. Any field Contains "travel", AND Any field Contains "lockdown" (34)
34. Any field Contains "travel", AND Any field Contains "ban" (46)
34. Any field Contains "visa" (17)

[or/1-34] (302)

## Appendix 4. Data extraction categories

### Study information

- Study ID
- Study title
- Study source (i.e. journal, report, preprint publication)
- Date of submission

- Date of publication

#### Study type

- Study type (e.g. experimental, quasi-experimental, observational, modelling)
- Verbal summary of study type (e.g. stochastic discrete event simulation model)
- Comments

#### Population, setting, and context

- Country in which travel-related control measure is implemented
- Region protected by travel-related control measure
- Region restricted by travel-related control measure
- Short description of population studied (e.g. international travelers including flight passenger and crew members arriving between 27 April and 22 June 2009)
- Comments

#### Characteristics of pathogen/disease

- Disease (i.e. SARS, MERS, COVID-19)
- **Incubation period**
- **Latent period**
- **Infectiousness of symptomatic persons**
- **Infectiousness of asymptomatic persons**
- Comments

#### Context of pathogen/disease transmission

- Stage of pandemic in the protected and restricted regions during which the intervention was implemented (i.e. no cases, sporadic cases, clusters of cases, and community transmission)
  - \* Supporting information for the categorization of the stage of pandemic in the protected and restricted regions (e.g. date of notification of first case, current number of cases, established community spread)
- **Reproduction number: basic reproduction number ( $R_0$ ) and current reproduction number  $R(t)$  for the region protected by the intervention**

#### Intervention

- Broad measure category (i.e. closure of national borders to entry/exit, international travel restrictions/bans, entry/exit screening at national borders, quarantine or isolation of travelers crossing national borders)
- Verbal summary of specific travel-related measure(s) (e.g. all arriving passengers were provided with a symptom questionnaire)
- Date(s) of implementation of the travel-related control measure(s)
- Any reported exceptions to the measure (e.g. certain individuals being excluded or fast-tracked in airport screening because of nationality, occupation, country of origin)
- **Representation of the intervention in the model (e.g. 100% travel reduction)**
- Comments

#### Primary outcomes (repeated for each primary outcome)

- Outcome category (i.e. cases avoided due to the intervention, number of cases detected due to the intervention, shift in epidemic development due to the intervention)
- Description of outcome
- Length of follow-up
- Estimate related to the impact of the travel-related control measure
- Narrative summary of overall impact of travel-related control measure
- **Additional analysis used to quantify the range of potential effects for this outcome**
- Comments

#### Secondary outcomes (repeated for each secondary outcome)

- Description of any secondary (non-quantitative) outcomes (i.e. any other infectious disease transmission outcomes, healthcare utilisation outcomes, resource requirements for implementing the intervention, and any adverse effects)
- Narrative results of secondary outcomes
- Comments

(External sources) Stage of pandemic in protected and restricted regions during which the intervention was implemented (i.e. no cases, sporadic cases, clusters of cases, and community transmission) – for each aspect extracted the exact source will be documented

(External sources) Intervention – for each aspect extracted the exact source will be documented

- Verbal summary of specific travel-related measure(s) (e.g. all arriving passengers were provided with a symptom questionnaire)
- Date(s) of implementation of the travel-related control measure(s)
- Any reported exceptions to the measure (e.g. certain individuals being excluded or fast-tracked in airport screening because of nationality, occupation, country of origin)

## Appendix 5. QUADAS-2 domains as applied in the rapid review

| Domain                          |                                     | Signalling question                                                                                  | Application in this review                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|---------------------------------|-------------------------------------|------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Domain 1: participant selection | A. Risk of bias                     | 1.1 Was a consecutive or random sample of participants enrolled?                                     | Assess how the individuals screened and/or quarantined as part of the study were determined; where all individuals were screened (e.g. as part of a blanket screening/quarantine programme at a port of entry or an evacuation flight) or where a random sample was selected, a risk of bias is not likely.                                                                                                                                                                                                                                                                                                                                                                      |
|                                 |                                     | 1.2 Was a case-control design avoided?                                                               | If disease status was used to determine the sample, a risk of bias should be considered.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                 |                                     | 1.3 Did the study avoid inappropriate exclusions?                                                    | Any exclusions to screening/quarantine programmes should be justified; however even with justification, exclusions could lead to bias, especially where the screening and disease status of those excluded are unknown. Thus, if no exclusion criteria were applied, the risk of bias is low.                                                                                                                                                                                                                                                                                                                                                                                    |
|                                 |                                     | Comments                                                                                             | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                 |                                     | 1. Could the selection of participants have introduced bias?                                         | Consider whether bias may have arisen from 1.1-1.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                                 | B. Concerns regarding applicability | Describe included participants (prior testing, presentation, intended use of index test and setting) | Consider those individuals screened, and whether they are representative of individuals to be screened as part of screening programmes at international borders likely to be used during the COVID-19 pandemic. For example, screening interventions targeting travellers or commuters at sea ports, airports or land borders under regular travelling conditions are often assumed to have a high external validity; while the individuals evacuated from a high-risk region (often from Wuhan, China, in the early phase of the pandemic) are likely to be different from regular travellers and these studies should be therefore regarded as having a low external validity. |
|                                 |                                     | Is there concern that the included participants do not match the review question?                    | See above                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

(Continued)

|                                                 |                                     |                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-------------------------------------------------|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Domain 2: index test(s)                         | A. Risk of bias                     | 2.1 Can we be sure that those identified in index test (true and false positive screening results) were identified by the index test (e.g. automated fever scanner) rather than any other means (e.g. self-reporting)? | Consider how those screened positive were determined – for entry/exit symptom-based screening all ‘positives’ should stem from the symptom screening (e.g. a febrile COVID-19 was who was identified by a thermal imaging system at an airport), and not from any other procedures (e.g. self-reporting of cases missed by the screening intervention; based on respiratory symptoms).                                                                                                                                                                                                                                                                                                                                                   |
|                                                 |                                     | 2.2 Were the index test results interpreted without knowledge of the results of the reference standard?                                                                                                                | Consider whether, for example, the results of the PCR test were known when symptom or fever screening was applied to individuals.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                 |                                     | 2.3 If a threshold was used, was it prespecified?                                                                                                                                                                      | Consider for temperature screening, whether the cut-off for determining acceptable/high temperature was predefined; for symptom screening, consider whether any symptom or a certain threshold of symptoms was used in defining whether an individual was symptomatic and whether this was predefined.                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                                                 |                                     | Comments on risk of bias                                                                                                                                                                                               | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                 |                                     | 2. Could the conduct or interpretation of the index test have introduced bias?                                                                                                                                         | Consider whether bias may have arisen from 2.1-2.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                                                 | B. Concerns regarding applicability | Describe the index test and how it was conducted and interpreted                                                                                                                                                       | Consider the screening/quarantine program assessed, and whether it is representative of one likely to be applied as part of screening programs at international borders during the COVID-19 pandemic. For example, screening interventions such as thermal imaging systems implemented at an airport to detect febrile individuals are assumed to have a high external validity; while the comprehensive medical examinations and observations conducted as part of the repatriation studies (studies in which individuals evacuated from a high risk region (often from Wuhan, China, in the early phase of the pandemic), which were not part of routine border crossing screening, should be regarded as having low external validity |
|                                                 |                                     | Is there concern that the index test, its conduct, or interpretation differ from the review question?                                                                                                                  | See above                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Domain 3: approach to identify cases and timing | A. Risk of bias                     | 3.1 Is the reference standard (the approach to identify and classify ‘cases’) likely to correctly classify the target condition (is there                                                                              | Consider whether the approach to identify cases may have missed relevant cases or classified individuals not infected with SARS-CoV-2 as a case. Any method other than positive PCR test results can be considered at high risk of bias.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

(Continued)

active infection with SARS-CoV-2)?

For the studies using a case-classification based on a positive PCR tests, we assumed the risk of bias due to false positives as low due to the high specificity of the PCR test (in particular if the population is assumed to have a high risk of infection).

However, there is a considerable risk of false negatives for the PCR test, primarily due to the course of infection (e.g. very low probability of detection in the first days after infection), but also due to inadequate procedures for specimen collection, handling, transportation, or storage (e.g. if only a single test shortly after an infection is applied to a swab sample, the viral load in the individual may not have been high enough for detection, leading to a false negative test).

We therefore assume a high risk of bias in studies, where asymptomatic individuals do not receive at least two PCR tests and symptomatic individuals did not receive at least two PCR tests after symptom onset.

3.2. Were the reference standard results interpreted without knowledge of the results of the index test?

Consider whether, for example, the results of the symptom screening were known when the classification was conducted. For PCR tests, where the a risk of subjective judgments to have led to a risk of erroneously classifying a test result as negative or positive is regarded as low, this knowledge of the outcome of the index test is still regarded as leading to a low risk of bias.

Comments on risk of bias

-

3.3 Could the reference standard, its conduct, or its interpretation of the have introduced bias?

Consider whether bias may have arisen from 3.1-3.2

Describe the reference standard and how it was conducted and interpreted

Consider the procedure for determining who receives the reference standard (the PCR test used to identify cases), and whether it is representative of that likely to be applied as part of screening programmes at international borders during the COVID-19 pandemic.

B. Concerns regarding applicability

Is there concern that the target condition as defined by the reference standard does not match the review question?

See above

4.1. Did all passengers receive the reference standard?

Consider whether all individuals received the reference test (the respective approach to identify and classify 'cases'; in most cases likely the PCR test).

For example, if only those who were screened positive (positive index test) and those who developed symptoms during a quarantine observational period were given a PCR test, as this would have led to a high risk of bias due to cases being missed).

(Continued)

|                           |                 |                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---------------------------|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                           |                 | <p>If individuals declined to or for other reasons receive the reference standard (e.g. PCR test), this could lead to cases being missed, which puts the study at a high risk of bias.</p> <p>Note: this is independent from 3.1, which evaluates the appropriateness of the approach to classify individuals as cases.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Domain 4: flow and timing | A. Risk of bias | 4.2. Did all passengers receive the same reference standard?                                                                                                                                                                                                                                                                | <p>Consider whether the procedure for identifying cases was the same across all individuals or whether it was applied differently without an adequate justification (e.g. individuals with symptoms receiving a different testing procedure).</p> <p>Studies, which used different approaches for classifying cases (e.g. some cases defined based on chest computer tomography and some based on PCR) would be classified as high risk of bias.</p> <p>Studies in which the classification of cases is based on multiple PCR tests, we consider a high risk of bias if some symptomatic individuals were treated differently from other symptomatic individuals (e.g. some received more PCR tests than others) and if some of the asymptomatic individuals were treated differently from asymptomatic individuals.</p> |
|                           |                 | 4.3. Were all passengers included in the analysis?                                                                                                                                                                                                                                                                          | Consider whether some individuals may have been excluded from the analysis, this would lead to a high risk of bias.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                           |                 | Is there likely no or a very low risk of attrition bias?                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|                           |                 | 4.4. Is it possible that the true disease status could have changed between the application of the index test and the reference standard? (e.g. additional infections through how the quarantine was handled?)                                                                                                              | Consider whether individuals may have become infected after the initial screening, e.g. if being quarantined among other infected individuals led to some initially non-infected individuals becoming infected. If there is a high risk that individuals who were classified as cases were not cases (i.e. not infected with SARS-CoV-2) at the time when the index test was applied, this would lead to a high risk of bias.                                                                                                                                                                                                                                                                                                                                                                                            |
|                           |                 | Comments on risk of bias                                                                                                                                                                                                                                                                                                    | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|                           |                 | 4. Could the passenger flow have introduced bias?                                                                                                                                                                                                                                                                           | Consider whether bias may have arisen from 4.1-4.4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

## Appendix 6. Criteria used for assessing the quality of individual modelling studies

| Aspect | Source | Questions | Application in this review |
|--------|--------|-----------|----------------------------|
|--------|--------|-----------|----------------------------|

(Continued)

|                       |              |                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------|--------------|-------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Model structure       | Philips 2006 | 1. Are the structural assumptions transparent and justified?                                                                        | 1. Assess whether all structural model assumptions are explicitly stated and whether the authors substantiate these assumptions either through theoretical reasoning or through prior knowledge from the literature.                                                                                                                                                      |
|                       |              | 2. Are the structural assumptions reasonable given the overall objective, perspective and scope of the model?                       | 2. Consider whether the structural assumptions are consistent with what is known about the phenomenon of interest in the literature. In case of disagreement, assess to what extent these discrepancies undermine the overall validity of results and conclusions.                                                                                                        |
| Input data            | Caro 2014    | 3. Are the input parameters transparent and justified?                                                                              | 3. Assess whether the values of all input parameters are explicitly stated and whether the authors substantiate these values either through theoretical reasoning or through prior knowledge from the literature.                                                                                                                                                         |
|                       |              | 4. Are the input parameters reasonable?                                                                                             | 4. Consider whether the input parameter values are consistent with what is known about the phenomenon of interest in the literature. In case of disagreement, assess to what extent these discrepancies undermine the overall validity of results and conclusions.                                                                                                        |
| Validation (external) | Caro 2014    | 5. Has the external validation process been described?                                                                              | 5. Assess whether there was a formal process of comparing the predictions of the model with 1) the data source that was used to build the model (dependent validation), 2) a data source that was not used to build the model, e.g. an independent country (independent validation) or 3) future values that did not intervene in model building (predictive validation). |
|                       |              | 6. Has the model been shown to be externally valid?                                                                                 | 6. Consider the extent to which model predictions agree with the data sources that were selected for the external validation process.                                                                                                                                                                                                                                     |
| Validation (internal) | Caro 2014    | 7. Has the internal validation process been described?                                                                              | 7. Assess whether there was a formal process of verifying the extent to which the mathematical calculations are consistent with the model's specifications, e.g. in the form of a simulation study in which the mathematical calculations are applied to data that were simulated according to the model with known parameter values.                                     |
|                       |              | 8. Has the model been shown to be internally valid?                                                                                 | 8. Consider the extent to which the results of the internal validation process indicate that the mathematical calculations are consistent with the model's specifications.                                                                                                                                                                                                |
| Uncertainty           | Caro 2014    | 9. Was there an adequate assessment of the effects of uncertainty?                                                                  | 9. Consider whether the robustness of results to alternative input parameter values or model assumptions was assessed either by reporting the results of specific sensitivity analyses or through an app in which readers can themselves explore the effects of varying these model assumptions and input parameter values.                                               |
| Transparency          | Caro 2014    | 10. Was technical documentation, in sufficient detail to allow (potentially) for replication, made available openly or under agree- | 10. Assess whether the description of the analyses (including model structure, input parameters, data sources and methods) is sufficiently detailed to allow for the replication of results. In particular, consider whether the code that was used to obtain the results is freely available and well documented.                                                        |

(Continued)

ments that protect intellectual property?

## Appendix 7. QUADAS-2 Risk of bias and applicability assessment of observational screening studies

| Study ID                    | Domain                              | Signalling Question                                                                                | Rating                                                                                                                                                                                                                            |
|-----------------------------|-------------------------------------|----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Entry/exit screening</b> |                                     |                                                                                                    |                                                                                                                                                                                                                                   |
| Arima 2020                  | Domain 1: passenger selection       | A. Risk of bias                                                                                    | 1.1 Was a consecutive or random sample of passengers enrolled? <b>Yes</b>                                                                                                                                                         |
|                             |                                     |                                                                                                    | 1.2 Was a case-control design avoided? <b>Yes</b>                                                                                                                                                                                 |
|                             |                                     |                                                                                                    | 1.3 Did the study avoid inappropriate exclusions? <b>Yes</b>                                                                                                                                                                      |
|                             |                                     | Comments                                                                                           | All 566 passengers repatriated were screened and followed up over the 14-day quarantine period                                                                                                                                    |
|                             |                                     | 1. Could the selection of passengers have introduced bias?                                         | <b>Low</b>                                                                                                                                                                                                                        |
|                             | B. Concerns regarding applicability | Describe included passengers (prior testing, presentation, intended use of index test and setting) | The population is a highly selected sample in the early phase of the pandemic and does not represent regular air travel passengers who would travel between China and Japan                                                       |
|                             |                                     | Is there concern that the included passengers do not match the review question?                    |                                                                                                                                                                                                                                   |
|                             |                                     |                                                                                                    |                                                                                                                                                                                                                                   |
|                             | Domain 2: index test(s)             | A. Risk of bias                                                                                    | 2.1 Can we be sure that those identified in index test (true and false positive screening results) were identified by the index test (e.g. automated fever scanner) rather than any other means (e.g. self-reporting)? <b>Yes</b> |
|                             |                                     |                                                                                                    | 2.2 Were the index test results interpreted without knowledge of the results of the reference standard? <b>Yes</b>                                                                                                                |
|                             |                                     |                                                                                                    | 2.3 If a threshold was used, was it prespecified? <b>Unclear</b>                                                                                                                                                                  |
|                             |                                     | Comments on risk of bias                                                                           |                                                                                                                                                                                                                                   |

(Continued)

|                                         |                                     |                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------------|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                         |                                     | 2. Could the conduct or interpretation of the index test have introduced bias?                                                                                           | <b>Low</b>                                                                                                                                                                                                                                                                                                                                                                 |
| Domain 3: reference standard and timing | B. Concerns regarding applicability | Describe the index test and how it was conducted and interpreted:                                                                                                        | Repatriation study, real-world generalizability should be considered Day 1 entry screening by testing oropharyngeal swab samples collected from all 566 returnees at the hospitals to which they were initially transported for SARS-CoV-2 (4); all tests were based on the real-time reverse transcription PCR developed by the National Institute of Infectious Diseases |
|                                         |                                     | Is there concern that the index test, its conduct, or interpretation differ from the review question?                                                                    | <b>Unclear</b>                                                                                                                                                                                                                                                                                                                                                             |
|                                         | A. Risk of bias                     | 3.1 Is the reference standard (the approach to identify and classify 'cases') likely to correctly classify the target condition (here active infection with SARS-CoV-2)? | <b>Yes</b>                                                                                                                                                                                                                                                                                                                                                                 |
|                                         |                                     | 3.2. Were the reference standard results interpreted without knowledge of the results of the index test?                                                                 | <b>Unclear</b>                                                                                                                                                                                                                                                                                                                                                             |
|                                         |                                     | Comments on risk of bias                                                                                                                                                 | Reference test was given at both entry and 14 days later at quarantine exit; there is a slight chance given the incubation and infectiousness periods that some cases were not captured, however this risk is low                                                                                                                                                          |
|                                         |                                     | 3. Could the reference standard, its conduct, or its interpretation have introduced bias?                                                                                | <b>Low</b>                                                                                                                                                                                                                                                                                                                                                                 |
|                                         | B. Concerns regarding applicability | Describe the reference standard and how it was conducted and interpreted:                                                                                                | Exit screening for quarantined people who remained illness-free (i.e. not already identified as a case) by collecting oropharyngeal swab samples on day 14, the end of the quarantine period                                                                                                                                                                               |
|                                         |                                     | Is there concern that the target condition as defined by the reference standard does not match the review question?                                                      | <b>Low</b>                                                                                                                                                                                                                                                                                                                                                                 |

(Continued)

|            |                               |                                     |                                                                                                                                                                                   |                                                                                                                                                                               |
|------------|-------------------------------|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|            | Domain 4: flow and timing     | A. Risk of bias                     | 4.1 Did all passengers receive the reference standard?                                                                                                                            | <b>Yes</b>                                                                                                                                                                    |
|            |                               |                                     | 4.2 Did all passengers receive the same reference standard?                                                                                                                       | <b>Yes</b>                                                                                                                                                                    |
|            |                               |                                     | 4.3 Were all passengers included in the analysis?<br>Is there likely no or a very low risk of attrition bias?                                                                     | <b>Yes</b>                                                                                                                                                                    |
|            |                               |                                     | 4.4 Did the quarantine procedure ensure that further individuals were not infected from being in quarantine? (e.g. additional infections through how the quarantine was handled?) | <b>Unclear</b>                                                                                                                                                                |
|            |                               |                                     | Comments on risk of bias                                                                                                                                                          | All passengers received the reference test at least once at entry and once at quarantine exit                                                                                 |
|            |                               |                                     | 4. Could the passenger flow have introduced bias?                                                                                                                                 | <b>Low</b>                                                                                                                                                                    |
| Hoehl 2020 | Domain 1: passenger selection | A. Risk of bias                     | 1.1 Was a consecutive or random sample of passengers enrolled?                                                                                                                    | <b>Yes</b>                                                                                                                                                                    |
|            |                               |                                     | 1.2 Was a case-control design avoided?                                                                                                                                            | <b>Yes</b>                                                                                                                                                                    |
|            |                               |                                     | 1.3 Did the study avoid inappropriate exclusions?                                                                                                                                 | <b>Yes</b>                                                                                                                                                                    |
|            |                               |                                     | Comments                                                                                                                                                                          | All 126 passengers on board the aircraft from Wuhan received the index test. Likely low risk of selection bias                                                                |
|            |                               |                                     | 1. Could the selection of passengers have introduced bias?                                                                                                                        | <b>Low</b>                                                                                                                                                                    |
|            |                               | B. Concerns regarding applicability | Describe included passengers (prior testing, presentation, intended use of index test and setting):                                                                               | The population is a highly selected sample in the early phase of the pandemic and does not represent regular air travel passengers who would travel between China and Germany |
|            |                               |                                     | Is there concern that the included passengers do not match the review question?                                                                                                   | High                                                                                                                                                                          |
|            | Domain 2: index test(s)       | A. Risk of bias                     | 2.1 Can we be sure that those identified in index test (true and false positive screening results) were identified by the index test (e.g. automated fever scanner)               | <b>Yes</b>                                                                                                                                                                    |

(Continued)

|                                     |                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------------------------|---------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                     | rather than any other means (e.g. self-reporting)?                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|                                     | 2.2 Were the index test results interpreted without knowledge of the results of the reference standard? | <b>Yes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                                     | 2.3 If a threshold was used, was it prespecified?                                                       | <b>Unclear</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|                                     | Comments on risk of bias                                                                                | The study does not provide information on the first screening in China and does not explicitly state that the measures were predefined. But this seems to be likely.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                                     | 2. Could the conduct or interpretation of the index test have introduced bias?                          | <b>Low</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| B. Concerns regarding applicability | Describe the index test and how it was conducted and interpreted                                        | <p>The two-step screening procedure was not a regular airport screening, but rather an intervention that is similar to a symptom- and exposure-based screening that could be conducted in the same way "Screening for symptoms and clinical signs of infection was performed before their departure from China" "During the flight, 10 passengers were isolated. "These 10 passengers were transferred to University Hospital Frankfurt immediately after arrival."</p> <p>"Two passengers had had contact with 1 person who had a confirmed case of SARS-CoV-2 infection, 6 had reported symptoms, were deemed to be clinically symptomatic, or both, and 2 passengers had accompanied family members who had been isolated on the flight because of suspected SARS-CoV-2 infection or because of other symptoms (i.e., symptoms related to pregnancy)."</p> <p>"The remaining 116 passengers [...] were sent to the medical assessment center at Frankfurt Airport, where each was evaluated by a medical team of physicians. Each passenger was asked to report current symptoms of fever, fatigue, sore throat, cough, runny nose, muscle aches, and diarrhea, and each one was screened for signs of infection in the nose and throat.</p> |

(Continued)

|                                         |                          |                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------------|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                         |                          | The temperature of all passengers was taken."                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                                         |                          | Is there concern that the index test, its conduct, or interpretation differ from the review question?                                                                    | High                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Domain 3: reference standard and timing | A. Risk of bias          | 3.1 Is the reference standard (the approach to identify and classify 'cases') likely to correctly classify the target condition (here active infection with SARS-CoV-2)? | No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                         |                          | 3.2. Were the reference standard results interpreted without knowledge of the results of the index test?                                                                 | Unclear                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                                         | Comments on risk of bias |                                                                                                                                                                          | <p>1. likelihood of having missed a positive finding in reference test: unclear</p> <ul style="list-style-type: none"> <li>Passengers were isolated for 14 days; there should have been a chance of around 70% to show symptoms if a passenger was infected</li> <li>All but 1 passenger had received an RT-PCR test. However, limited information is provided to judge if there is a risk of bias due to (a) inadequate taking of the sample (likely low, if conducted by medical professional) and (b) inadequate transportation, storage, or delay in testing (likely low, but unclear).</li> <li>It is unclear, (a) at what point of time during the quarantine the test was conducted, (b) if it was repeated (2 tests per person), and (c) if the repetition of the two tests (if there were 2) had an sufficient delay.</li> </ul> <p>2. likelihood of having misclassified a positive case in reference test: probability is low, cases received 3 tests (at least 2 RT-PCRs and 1 cell culture test)</p> |
|                                         |                          | 3. Could the reference standard, its conduct, or its interpretation have introduced bias?                                                                                | High                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|                                         |                          | B. Concerns regarding applicability                                                                                                                                      | Describe the reference standard and how it was conducted and interpreted:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                         |                          |                                                                                                                                                                          | <ul style="list-style-type: none"> <li>All 11 passengers with positive screening results received a RT-PCR</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

(Continued)

- For those remaining 116 passengers in quarantine, 115 received the test (1 person declined; no reasons provided)
- 2 passengers had a positive test result from RT-PCR, which was later confirmed by a second test.

"RT-PCR (cycle threshold value in the two samples, 24.39 and 30.25, respectively). Testing with a second protocol consisting of two commercial sets (LightMix Modular SARS and Wuhan CoV E-gene, and LightMix Modular Wuhan CoV RdRP-gene, both produced by TIB MOLBIOL) and retesting of the positive samples at the Institute of Virology, Philipps University Marburg, in Marburg, Germany, confirmed the results"

Is there concern that the target condition as defined by the reference standard does not match the review question?

**Low**

Domain 4: flow and timing

A. Risk of bias

4.1 Did all passengers receive the reference standard?

4.2 Did all passengers receive the same reference standard?

**Yes**

4.3 Were all passengers included in the analysis?  
Is there likely no or a very low risk of attrition bias?

**Unclear**

4.4 Did the quarantine procedure ensure that further individuals were not infected from being in quarantine? (e.g. additional infections through how the quarantine was handled?)

**Unclear**

Comments on risk of bias

All but one passenger received the standard test (1/126)  
The risk of bias resulting from this is considered low, but the reasons for rejecting the reference test are unclear.  
Limited information on the quarantine procedure is reported

4. Could the passenger flow have introduced bias?

**Unclear**

Jernigan 2020

Domain 1: passenger selection

A. Risk of bias

1.1 Was a consecutive or random sample of passengers enrolled?

**Yes**

(Continued)

|                         |                                     |                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                        |
|-------------------------|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                         |                                     | 1.2 Was a case-control design avoided?                                                                                                                                                                                 | <b>Yes</b>                                                                                                                                                                                                                                                                                                                                                             |
|                         |                                     | 1.3 Did the study avoid inappropriate exclusions?                                                                                                                                                                      | <b>Unclear</b>                                                                                                                                                                                                                                                                                                                                                         |
|                         |                                     | Comments                                                                                                                                                                                                               | It seems that all repatriated passengers received the screening. But there are some uncertainties remaining                                                                                                                                                                                                                                                            |
|                         |                                     | 1. Could the selection of passengers have introduced bias?                                                                                                                                                             | <b>Low</b>                                                                                                                                                                                                                                                                                                                                                             |
| Domain 2: index test(s) | B. Concerns regarding applicability | Describe included passengers (prior testing, presentation, intended use of index test and setting):                                                                                                                    | The population is a highly selected sample in the early phase of the pandemic and does not represent regular air travel passengers which would travel                                                                                                                                                                                                                  |
|                         |                                     | Is there concern that the included passengers do not match the review question?                                                                                                                                        | High                                                                                                                                                                                                                                                                                                                                                                   |
|                         | A. Risk of bias                     | 2.1 Can we be sure that those identified in index test (true and false positive screening results) were identified by the index test (e.g. automated fever scanner) rather than any other means (e.g. self-reporting)? | <b>Yes</b>                                                                                                                                                                                                                                                                                                                                                             |
|                         |                                     | 2.2 Were the index test results interpreted without knowledge of the results of the reference standard?                                                                                                                | <b>Yes</b>                                                                                                                                                                                                                                                                                                                                                             |
|                         |                                     | 2.3 If a threshold was used, was it prespecified?                                                                                                                                                                      | <b>Unclear</b>                                                                                                                                                                                                                                                                                                                                                         |
|                         |                                     | Comments on risk of bias                                                                                                                                                                                               | There is limited information available on the symptom-based screening                                                                                                                                                                                                                                                                                                  |
|                         |                                     | 2. Could the conduct or interpretation of the index test have introduced bias?                                                                                                                                         | <b>Low</b>                                                                                                                                                                                                                                                                                                                                                             |
|                         |                                     | B. Concerns regarding applicability                                                                                                                                                                                    | Limited information available on how the screening was conducted Repatriation flights from areas with substantial COVID-19 transmission. During 29 January–6 February, the US government repatriated 808 US citizens, residents, and their families from Hubei Province, China, on five chartered flights. At the time of departure, all travellers were free of symp- |

(Continued)

|                                         |                                     |                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------------------------------------|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                         |                                     |                                                                                                                                                                          | toms for COVID-19 (fever or feverishness, cough, difficulty breathing)                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|                                         |                                     | Is there concern that the index test, its conduct, or interpretation differ from the review question?                                                                    | <b>Unclear</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Domain 3: reference standard and timing | A. Risk of bias                     | 3.1 Is the reference standard (the approach to identify and classify 'cases') likely to correctly classify the target condition (here active infection with SARS-CoV-2)? | No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|                                         |                                     | 3.2. Were the reference standard results interpreted without knowledge of the results of the index test?                                                                 | No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|                                         |                                     | Comments on risk of bias                                                                                                                                                 | <p>The reference test consisted of two parts:</p> <ul style="list-style-type: none"> <li>• observation of individuals for 14 days and</li> <li>• testing all those with symptoms</li> </ul> <p>As about a third of adults do not show symptoms, this approach is likely to miss relevant cases</p>                                                                                                                                                                                                                  |
|                                         |                                     | 3. Could the reference standard, its conduct, or its interpretation have introduced bias?                                                                                | High                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                         | B. Concerns regarding applicability | Describe the reference standard and how it was conducted and interpreted:                                                                                                | <p>After arriving in the USA, the repatriated travellers were quarantined for 14 days at one of five US military bases. CDC and US government staff members monitored these travellers' health. As of 23 February, 28 (3%) of these people developed COVID-19-related symptoms and were evaluated for infection; three were found to be positive for SARS-CoV-2 and were referred for medical care and isolation.</p> <p>As of 24 February, the remaining 805 travellers had completed their 14-day quarantine.</p> |
|                                         |                                     | Is there concern that the target condition as defined by the reference standard does not match the review question?                                                      | <b>Low</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Domain 4: flow and timing               | A. Risk of bias                     | 4.1 Did all passengers receive the reference standard?                                                                                                                   | <b>Yes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

(Continued)

|                         |                                     |                                                                                                                                                                                                                        |                                                                                                                                                                                          |                                                                                                                                                           |
|-------------------------|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
|                         |                                     |                                                                                                                                                                                                                        | 4.2 Did all passengers receive the same reference standard?                                                                                                                              | Unclear                                                                                                                                                   |
|                         |                                     |                                                                                                                                                                                                                        | 4.3 Were all passengers included in the analysis?<br>Is there likely no or a very low risk of attrition bias?                                                                            | Yes                                                                                                                                                       |
|                         |                                     |                                                                                                                                                                                                                        | 4.4 Did the quarantine procedure ensure that further individuals were not infected from being in quarantine? (e.g. additional infections through how the quarantine was handled?)        | Unclear                                                                                                                                                   |
|                         |                                     |                                                                                                                                                                                                                        | Comments on risk of bias                                                                                                                                                                 | 0 cases were positive in screening<br>Only those who developed symptoms (23 people) received the test                                                     |
|                         |                                     |                                                                                                                                                                                                                        | 4. Could the passenger flow have introduced bias?                                                                                                                                        | High                                                                                                                                                      |
| Lytras 2020             | Domain 1: passenger selection       | A. Risk of bias                                                                                                                                                                                                        | 1.1 Was a consecutive or random sample of passengers enrolled?                                                                                                                           | Unclear                                                                                                                                                   |
|                         |                                     |                                                                                                                                                                                                                        | 1.2 Was a case-control design avoided?                                                                                                                                                   | Yes                                                                                                                                                       |
|                         |                                     |                                                                                                                                                                                                                        | 1.3 Did the study avoid inappropriate exclusions?                                                                                                                                        | Yes                                                                                                                                                       |
|                         |                                     |                                                                                                                                                                                                                        | Comments                                                                                                                                                                                 | All passengers on board were screened; however, out of all repatriation flights, those 7 selected flights were chosen.<br>The reasons for this is unclear |
|                         |                                     |                                                                                                                                                                                                                        | 1. Could the selection of passengers have introduced bias?                                                                                                                               | Low                                                                                                                                                       |
|                         | B. Concerns regarding applicability | Describe included passengers (prior testing, presentation, intended use of index test and setting):                                                                                                                    | The population is a highly selected sample in the early phase of the pandemic and does not represent regular air travel passengers who would travel between Spain, UK, Turkey and Greece |                                                                                                                                                           |
|                         |                                     | Is there concern that the included passengers do not match the review question?                                                                                                                                        | High                                                                                                                                                                                     |                                                                                                                                                           |
| Domain 2: index test(s) | A. Risk of bias                     | 2.1 Can we be sure that those identified in index test (true and false positive screening results) were identified by the index test (e.g. automated fever scanner) rather than any other means (e.g. self-reporting)? | Unclear                                                                                                                                                                                  |                                                                                                                                                           |

(Continued)

|                                         |                                     |                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------------|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                         |                                     | 2.2 Were the index test results interpreted without knowledge of the results of the reference standard?                                                                  | <b>Yes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                         |                                     | 2.3 If a threshold was used, was it prespecified?                                                                                                                        | <b>Unclear</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                                         |                                     | Comments on risk of bias                                                                                                                                                 | Passengers reported symptoms and received some form of medical examination. It is unclear how the screening was handled. A swab was taken at the same time, therefore prior to knowing about the results of the reference test                                                                                                                                                                                                                                                                                                                                                    |
|                                         |                                     | 2. Could the conduct or interpretation of the index test have introduced bias?                                                                                           | <b>Unclear</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Domain 3: reference standard and timing | B. Concerns regarding applicability | Describe the index test and how it was conducted and interpreted:                                                                                                        | The symptom-based screening and how individual cases were handled is not well described. We do not know much about the screening procedure (index test) "All passengers consented to screening, and were asked in-flight to fill in a paper form with demographic, clinical and contact information. A temporary facility was set up by NPHO at a gate in Athens airport 'Eleftherios Venizelos', and swab samples were obtained from passengers immediately upon arrival; those not in need of medical care were subsequently requested to self-quarantine at home for 14 days." |
|                                         |                                     | Is there concern that the index test, its conduct, or interpretation differ from the review question?                                                                    | <b>Unclear</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                                         | A. Risk of bias                     | 3.1 Is the reference standard (the approach to identify and classify 'cases') likely to correctly classify the target condition (here active infection with SARS-CoV-2)? | No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                         |                                     | 3.2. Were the reference standard results interpreted without knowledge of the results of the index test?                                                                 | <b>Unclear</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                                         |                                     | Comments on risk of bias                                                                                                                                                 | One-time PCR test upon arrival. No additional reference tests are reported, even among those 36 who developed symptoms in the course                                                                                                                                                                                                                                                                                                                                                                                                                                              |

(Continued)

|                           |                                     |                                                                                                                                                                                   |                                                                                           |                                                                                                                                                                                                                                                                                                                                            |
|---------------------------|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                           |                                     |                                                                                                                                                                                   |                                                                                           | of the quarantine. Limited information on how the swab was taken is reported                                                                                                                                                                                                                                                               |
|                           |                                     |                                                                                                                                                                                   | 3. Could the reference standard, its conduct, or its interpretation have introduced bias? | High                                                                                                                                                                                                                                                                                                                                       |
|                           | B. Concerns regarding applicability | Describe the reference standard and how it was conducted and interpreted                                                                                                          |                                                                                           | All passengers received the screening test and reference test upon arrival. Only one reference test RT-PCR was conducted, leading to the risk of false negatives. An additional 36 passengers in quarantine with negative tests had developed symptoms in quarantine. It is possible that a proportion of them was suffering from COVID-19 |
|                           |                                     | Is there concern that the target condition as defined by the reference standard does not match the review question?                                                               |                                                                                           | <b>Low</b>                                                                                                                                                                                                                                                                                                                                 |
| Domain 4: flow and timing | A. Risk of bias                     | 4.1 Did all passengers receive the reference standard?                                                                                                                            |                                                                                           | <b>Yes</b>                                                                                                                                                                                                                                                                                                                                 |
|                           |                                     | 4.2 Did all passengers receive the same reference standard?                                                                                                                       |                                                                                           | <b>Yes</b>                                                                                                                                                                                                                                                                                                                                 |
|                           |                                     | 4.3 Were all passengers included in the analysis?<br>Is there likely no or a very low risk of attrition bias?                                                                     |                                                                                           | <b>Yes</b>                                                                                                                                                                                                                                                                                                                                 |
|                           |                                     | 4.4 Did the quarantine procedure ensure that further individuals were not infected from being in quarantine? (e.g. additional infections through how the quarantine was handled?) |                                                                                           | <b>Unclear</b>                                                                                                                                                                                                                                                                                                                             |
|                           |                                     | Comments on risk of bias                                                                                                                                                          |                                                                                           | All passengers received the reference test, there is no indication of a different treatment or of attrition bias                                                                                                                                                                                                                           |
|                           |                                     | 4. Could the passenger flow have introduced bias?                                                                                                                                 |                                                                                           | <b>Low</b>                                                                                                                                                                                                                                                                                                                                 |
| Ng 2020                   | Domain 1: passenger selection       | A. Risk of bias                                                                                                                                                                   | 1.1 Was a consecutive or random sample of passengers enrolled?                            | <b>Yes</b>                                                                                                                                                                                                                                                                                                                                 |
|                           |                                     |                                                                                                                                                                                   | 1.2 Was a case-control design avoided?                                                    | <b>Yes</b>                                                                                                                                                                                                                                                                                                                                 |
|                           |                                     |                                                                                                                                                                                   | 1.3 Did the study avoid inappropriate exclusions?                                         | <b>No</b>                                                                                                                                                                                                                                                                                                                                  |

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|                         |                                     |                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                         |                                     | Comments                                                                                                                                                                                                               | Here, 3 febrile passengers were removed from the pool and we do not have information on their diagnosis; thus removing infected passengers at this point would lead to an underestimate of the screening                                                                                                                                                                                                                                                                                                                                                                                                  |
|                         |                                     | 1. Could the selection of passengers have introduced bias?                                                                                                                                                             | <b>No</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Domain 2: index test(s) | B. Concerns regarding applicability | Describe included passengers (prior testing, presentation, intended use of index test and setting):                                                                                                                    | Repatriation study, transferability to the real world as a screening intervention is unclear.<br>"We followed up on 94 persons who boarded an evacuation flight from Wuhan to Singapore on January 30, 2020."                                                                                                                                                                                                                                                                                                                                                                                             |
|                         |                                     | Is there concern that the included passengers do not match the review question?                                                                                                                                        | High                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                         | A. Risk of bias                     | 2.1 Can we be sure that those identified in index test (true and false positive screening results) were identified by the index test (e.g. automated fever scanner) rather than any other means (e.g. self-reporting)? | <b>Yes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                         |                                     | 2.2 Were the index test results interpreted without knowledge of the results of the reference standard?                                                                                                                | <b>Yes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                         |                                     | 2.3 If a threshold was used, was it prespecified?                                                                                                                                                                      | <b>Yes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                         |                                     | Comments on risk of bias                                                                                                                                                                                               | On arrival in Singapore, the passengers underwent repeat screening for body temperature (fever was defined as a body temperature $\geq 38^{\circ}\text{C}$ ), and 2 people had a fever<br><br>Co-intervention <ul style="list-style-type: none"> <li>Airport departure fever screening: screening for body temperature was conducted at check-in and before boarding, and 3 febrile people were prevented from boarding (no additional information regarding the status of these 3 febrile people was available)</li> <li>Masks: surgical masks were provided to passengers on board the plane</li> </ul> |

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|                                         |                                     |                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------------|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                         |                                     | 2. Could the conduct or interpretation of the index test have introduced bias?                                                                                           | <b>Low</b>                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Domain 3: reference standard and timing | B. Concerns regarding applicability | Describe the index test and how it was conducted and interpreted:                                                                                                        | Repatriation-study, transferability to the real world as a screening intervention is unclear. The 2 febrile women identified in arrival screening were transferred immediately to a hospital, and they tested positive for SARS-CoV-2 (their clinical course is described in the Supplementary Appendix)                                                                                                                                          |
|                                         |                                     | Is there concern that the index test, its conduct, or interpretation differ from the review question?                                                                    | <b>Unclear</b>                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                                         | A. Risk of bias                     | 3.1 Is the reference standard (the approach to identify and classify 'cases') likely to correctly classify the target condition (here active infection with SARS-CoV-2)? | No                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                         |                                     | 3.2. Were the reference standard results interpreted without knowledge of the results of the index test?                                                                 | No                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                         |                                     | Comments on risk of bias                                                                                                                                                 | While the reference test is not perfect, most passengers received at least 2 PCR tests with 3 days in between, were observed intensely for 14 days, and tested in the case of symptoms. There is a risk of passengers being missed by this procedure, but likely this number is low.                                                                                                                                                              |
|                                         |                                     | 3. Could the reference standard, its conduct, or its interpretation have introduced bias?                                                                                | <b>High</b>                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                                         | B. Concerns regarding applicability | Describe the reference standard and how it was conducted and interpreted:                                                                                                | 1. Quarantine and observation for 14 days and checking of symptoms and fever three times daily<br>2. PCR assessment of those showing symptoms → those with symptoms received only 1 test<br>3. On quarantine day 3, samples from 76 of the 86 asymptomatic people (75 nasopharyngeal swab samples and 1 nasal swab sample) were obtained and tested by means of PCR assay<br>4. On quarantine day 6, samples from all 87 quarantined asymptomatic |

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matic people (85 nasopharyngeal swab samples and 2 nasal swab samples (3 of the 6 people who had been transferred to the hospital before February 2 had returned to the government quarantine facility)) were obtained and tested; all tested negative.

|               |                               |                                     |                                                                                                                                                                                   |                                                                                                                                                                                                                             |
|---------------|-------------------------------|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|               |                               |                                     | Is there concern that the target condition as defined by the reference standard does not match the review question?                                                               | <b>Low</b>                                                                                                                                                                                                                  |
|               | Domain 4: flow and timing     | A. Risk of bias                     | 4.1 Did all passengers receive the reference standard?                                                                                                                            | <b>Yes</b>                                                                                                                                                                                                                  |
|               |                               |                                     | 4.2 Did all passengers receive the same reference standard?                                                                                                                       | <b>Yes</b>                                                                                                                                                                                                                  |
|               |                               |                                     | 4.3 Were all passengers included in the analysis?<br>Is there likely no or a very low risk of attrition bias?                                                                     | <b>Yes</b>                                                                                                                                                                                                                  |
|               |                               |                                     | 4.4 Did the quarantine procedure ensure that further individuals were not infected from being in quarantine? (e.g. additional infections through how the quarantine was handled?) | <b>Unclear</b>                                                                                                                                                                                                              |
|               |                               |                                     | Comments on risk of bias                                                                                                                                                          |                                                                                                                                                                                                                             |
|               |                               |                                     | 4. Could the passenger flow have introduced bias?                                                                                                                                 | <b>Low</b>                                                                                                                                                                                                                  |
| Yamahata 2020 | Domain 1: passenger selection | A. Risk of bias                     | 1.1 Was a consecutive or random sample of passengers enrolled?                                                                                                                    | <b>Yes</b>                                                                                                                                                                                                                  |
|               |                               |                                     | 1.2 Was a case-control design avoided?                                                                                                                                            | <b>Yes</b>                                                                                                                                                                                                                  |
|               |                               |                                     | 1.3 Did the study avoid inappropriate exclusions?                                                                                                                                 | <b>Yes</b>                                                                                                                                                                                                                  |
|               |                               |                                     | Comments                                                                                                                                                                          | All passengers and crew members received the index test                                                                                                                                                                     |
|               |                               |                                     | 1. Could the selection of passengers have introduced bias?                                                                                                                        | <b>Low</b>                                                                                                                                                                                                                  |
|               |                               | B. Concerns regarding applicability | Describe included passengers (prior testing, presentation, intended use of index test and setting):                                                                               | Not a real-world screening intervention. This is a situation which can be seen as analogous to a screening intervention<br>"On February 3, 2020, when the ship arrived at Yokohama, a quarantine was initiated. All passen- |

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|                         |                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-------------------------|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                         |                                     | <p>gers and crew underwent medical examinations. On February 5, the RT-PCR results from the throat swab for symptomatic people and their close contacts revealed that 10 of 31 individuals were positive for SARS-CoV-2. On the same day, the Japanese government decided that all passengers were to be quarantined in their cabins for 14 days [10]. Based on international guidance on infection control, the crew continued to maintain ship functions and support passengers for their food, clothing, and shelter-related needs."</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|                         |                                     | Is there concern that the included passengers do not match the review question?                                                                                                                                                                                                                                                                                                                                                                                                                                                             | High                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Domain 2: index test(s) | A. Risk of bias                     | 2.1 Can we be sure that those identified in index test (true and false positive screening results) were identified by the index test (e.g. automated fever scanner) rather than any other means (e.g. self-reporting)?                                                                                                                                                                                                                                                                                                                      | <b>Unclear</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                         |                                     | 2.2 Were the index test results interpreted without knowledge of the results of the reference standard?                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Yes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                         |                                     | 2.3 If a threshold was used, was it prespecified?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Unclear</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                         |                                     | Comments on risk of bias                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | The study provides very limited information on the screening measure                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|                         |                                     | 2. Could the conduct or interpretation of the index test have introduced bias?                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Unclear</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                         | B. Concerns regarding applicability | Describe the index test and how it was conducted and interpreted:                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <p>Not a real-world screening intervention. It is a situation which can be seen as analogous to a screening intervention</p> <p>"On February 3, 2020, when the ship arrived at Yokohama, a quarantine was initiated. All passengers and crew underwent medical examinations. On February 5, the RT-PCR results from the throat swab for symptomatic people and their close contacts revealed that 10 of 31 individuals were positive for SARS-CoV-2. On the same day, the Japanese government decid-</p> |

(Continued)

|                                         |                                     |                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------------|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                         |                                     | ed that all passengers were to be quarantined in their cabins for 14 days [10]. Based on international guidance on infection control, the crew continued to maintain ship functions and support passengers for their food, clothing, and shelter-related needs." |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                                         |                                     | Is there concern that the index test, its conduct, or interpretation differ from the review question?                                                                                                                                                            | <b>Low</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Domain 3: reference standard and timing | A. Risk of bias                     | 3.1 Is the reference standard (the approach to identify and classify 'cases') likely to correctly classify the target condition (here active infection with SARS-CoV-2)?                                                                                         | No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                         |                                     | 3.2. Were the reference standard results interpreted without knowledge of the results of the index test?                                                                                                                                                         | No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                         |                                     | Comments on risk of bias                                                                                                                                                                                                                                         | All passengers received a RT-PCR test. All passengers and crew were quarantined. Those developing symptoms received another RT-PCR test. There is a risk of infected being missed if they had no or low symptoms during the quarantine (about 30%) of infected                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|                                         |                                     | 3. Could the reference standard, its conduct, or its interpretation have introduced bias?                                                                                                                                                                        | High                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                                         | B. Concerns regarding applicability | Describe the reference standard and how it was conducted and interpreted:                                                                                                                                                                                        | "During the quarantine, RT-PCR testing of throat swabs was extended to all passengers in the following order:<br>On February 3, 2020, when the ship arrived at Yokohama, a quarantine was initiated. All passengers and crew underwent medical examinations.<br>On February 5, the RT-PCR results from the throat swab for symptomatic people and their close contacts revealed that 10 of 31 individuals were positive for SARS-CoV-2. On the same day, the Japanese government decided that all passengers were to be quarantined in their cabins for 14 days [10]. Based on international guidance on infection control, the crew continued to maintain ship functions and support passengers for their |

(Continued)

|                           |                               |                                                                                                                                                                                   |                                                                                                                                                                                                                                                                   |                                                                                                                                                                            |
|---------------------------|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                           |                               |                                                                                                                                                                                   |                                                                                                                                                                                                                                                                   | food, clothing, and shelter-related needs."                                                                                                                                |
|                           |                               |                                                                                                                                                                                   | Is there concern that the target condition as defined by the reference standard does not match the review question?                                                                                                                                               | <b>Low</b>                                                                                                                                                                 |
| Domain 4: flow and timing | A. Risk of bias               | 4.1 Did all passengers receive the reference standard?                                                                                                                            | <b>Yes</b>                                                                                                                                                                                                                                                        |                                                                                                                                                                            |
|                           |                               | 4.2 Did all passengers receive the same reference standard?                                                                                                                       | <b>Yes</b>                                                                                                                                                                                                                                                        |                                                                                                                                                                            |
|                           |                               | 4.3 Were all passengers included in the analysis?<br>Is there likely no or a very low risk of attrition bias?                                                                     | <b>Yes</b>                                                                                                                                                                                                                                                        |                                                                                                                                                                            |
|                           |                               | 4.4 Did the quarantine procedure ensure that further individuals were not infected from being in quarantine? (e.g. additional infections through how the quarantine was handled?) | No                                                                                                                                                                                                                                                                |                                                                                                                                                                            |
|                           |                               | Comments on risk of bias                                                                                                                                                          | Keeping passengers for 3 weeks on the ship could have led to the development of additional cases (close contact among infected). Thus using quarantine as part of the reference test would yield an underestimation of the effectiveness of the screening measure |                                                                                                                                                                            |
|                           |                               | 4. Could the passenger flow have introduced bias?                                                                                                                                 | High                                                                                                                                                                                                                                                              |                                                                                                                                                                            |
| Samaan 2004               | Domain 1: passenger selection | A. Risk of bias                                                                                                                                                                   | 1.1 Was a consecutive or random sample of passengers enrolled?                                                                                                                                                                                                    | <b>Yes</b>                                                                                                                                                                 |
|                           |                               |                                                                                                                                                                                   | 1.2 Was a case-control design avoided?                                                                                                                                                                                                                            | <b>Yes</b>                                                                                                                                                                 |
|                           |                               |                                                                                                                                                                                   | 1.3 Did the study avoid inappropriate exclusions?                                                                                                                                                                                                                 | <b>Yes</b>                                                                                                                                                                 |
|                           |                               |                                                                                                                                                                                   | Comments                                                                                                                                                                                                                                                          | It seems that all passengers underwent the screening intervention as described                                                                                             |
|                           |                               |                                                                                                                                                                                   | 1. Could the selection of passengers have introduced bias?                                                                                                                                                                                                        | <b>Low</b>                                                                                                                                                                 |
|                           |                               | B. Concerns regarding applicability                                                                                                                                               | Describe included passengers (prior testing, presentation, intended use of index test and setting):                                                                                                                                                               | Real-world screening intervention<br>The effectiveness of the border entry screening programme was assessed for arrivals between 5 April and 16 June 2003. This 72-day pe- |

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riod was a peak period in the global outbreak, during which 6044 of the total 8422 cases were reported. There were 1.84 million arrivals into Australia during the 72-day study period.

Of these, 241,491 (13.1%) arrived from countries with local transmission of SARS (i.e. Vietnam, Taiwan, Singapore, Hong Kong, Canada, China and the Philippines).

Of all arrivals, AQIS staff assessed 794 travellers.

Of these, 734 (92.4%) were referred by AQIS staff to the nurses at airports; this number constituted 3.1 travellers referred per 1000 arrivals from SARS-affected areas, and 0.4 travellers per 1000 arrivals from all ports of origin.

Nineteen people (2.4%) were then referred to the CQO.

Of the 19 travellers referred to the CQO, four were referred to hospital for further investigations.

Two additional travellers, who were asymptomatic, were placed under home surveillance, as they had been in recent close contact with SARS passengers.

|                         |                 |                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                 |
|-------------------------|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                         |                 | Is there concern that the included passengers do not match the review question?                                                                                                                                        | <b>Low</b>                                                                                                                                                                                                                                                                                                      |
| Domain 2: index test(s) | A. Risk of bias | 2.1 Can we be sure that those identified in index test (true and false positive screening results) were identified by the index test (e.g. automated fever scanner) rather than any other means (e.g. self-reporting)? | <b>Yes</b>                                                                                                                                                                                                                                                                                                      |
|                         |                 | 2.2 Were the index test results interpreted without knowledge of the results of the reference standard?                                                                                                                | <b>Yes</b>                                                                                                                                                                                                                                                                                                      |
|                         |                 | 2.3 If a threshold was used, was it prespecified?                                                                                                                                                                      | <b>Yes</b>                                                                                                                                                                                                                                                                                                      |
|                         |                 | Comments on risk of bias                                                                                                                                                                                               | Self-reporting was part of the screening intervention; screening took place before the reference tests. The procedure is well described and uses fixed definitions. The only uncertainty is the first level of screening: "detection of respiratory symptoms by custom staff at airport". Here, a level of sub- |

(Continued)

|                                         |                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                     |
|-----------------------------------------|-------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                         |                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | jectivity and variability is to be expected, however, this is the result of real-world interventions                                                                                                                                |
|                                         |                                                                   | 2. Could the conduct or interpretation of the index test have introduced bias?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Low</b>                                                                                                                                                                                                                          |
| B. Concerns regarding applicability     | Describe the index test and how it was conducted and interpreted: | <p>1. Symptom- and contact-based self-reporting and observational symptom-based screening by customs staff</p> <ul style="list-style-type: none"> <li>• Inflight notification by airline staff</li> <li>• Self-referral based on prior contact with SARS case or symptoms</li> <li>• Detection of respiratory symptoms by Customs staff at airport</li> </ul> <p>2. Referral to AQIS</p> <ul style="list-style-type: none"> <li>• Assessment of contact with SARS case</li> <li>• Assessment of travel history to SARS-affected area</li> </ul> <p>3. Referral to nurses</p> <ul style="list-style-type: none"> <li>• Applying WHO case definition</li> <li>• Recording of temperature</li> </ul> <p>4. Referral to CQO</p> <ul style="list-style-type: none"> <li>• Assessment if passenger meets WHO case definition</li> </ul> |                                                                                                                                                                                                                                     |
|                                         |                                                                   | Is there concern that the index test, its conduct, or interpretation differ from the review question?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Low</b>                                                                                                                                                                                                                          |
| Domain 3: reference standard and timing | A. Risk of bias                                                   | 3.1 Is the reference standard (the approach to identify and classify 'cases') likely to correctly classify the target condition (here active infection with SARS-CoV-2)?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Unclear</b>                                                                                                                                                                                                                      |
|                                         |                                                                   | 3.2. Were the reference standard results interpreted without knowledge of the results of the index test?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Unclear</b>                                                                                                                                                                                                                      |
|                                         |                                                                   | Comments on risk of bias                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <p>It is unclear, how the reference test (the hospital examination) was performed and the quality of the test.</p> <p>The SARS case register is likely to contain relevant cases, but is likely not to be complete in regard to</p> |

(Continued)

|                           |                                     |                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|---------------------------|-------------------------------------|---------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                           |                                     |                                                                                                                     | SARS cases. However, this is not clear                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                           |                                     | 3. Could the reference standard, its conduct, or its interpretation have introduced bias?                           | <b>Unclear</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|                           | B. Concerns regarding applicability | Describe the reference standard and how it was conducted and interpreted:                                           | <p>1. Those referred by the CQO underwent an in-depth medical assessment in a hospital. It is unclear, how this assessment was conducted and what it contains. Therefore, the probability of detecting true positive cases or misclassifying true negative cases as positive is unclear.</p> <p>2. The second level is the comparison of the data against the Australian SARS case register. This register contains 64 suspected and 13 probable SARS cases. "Based on the Australian SARS Case Register, 13 people were initially assessed as probable SARS cases and 64 as suspected SARS cases. Of these, five people from the former group and 24 from the latter group acknowledged being symptomatic on arrival (Box 3). However, border screening had detected only 4 (13.8%) of these 29 symptomatic travellers, although none of these people were later classified as probable SARS cases. Of the 25 people with symptoms who had been missed by border screening, one person was finally reported as a probable SARS case, but without local transmission of the disease. The remaining 24 did not have SARS, as an alternative diagnosis fully explained their illnesses, or they did not have a convincing exposure to the disease."</p> |
|                           |                                     | Is there concern that the target condition as defined by the reference standard does not match the review question? | <b>Low</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Domain 4: flow and timing | A. Risk of bias                     | 4.1 Did all passengers receive the reference standard?                                                              | No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                           |                                     | 4.2 Did all passengers receive the same reference standard?                                                         | No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                           |                                     | 4.3 Were all passengers included in the analysis?                                                                   | No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

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|----------------------|-------------------------------------|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                      |                                     |                 | Is there likely no or a very low risk of attrition bias?                                                                                                                                                               |                                                                                                                                                                                        |
|                      |                                     |                 | 4.4 Did the quarantine procedure ensure that further individuals were not infected from being in quarantine? (e.g. additional infections through how the quarantine was handled?)                                      | NA                                                                                                                                                                                     |
|                      |                                     |                 | Comments on risk of bias                                                                                                                                                                                               | There is a risk of the case register not having registered all SARS cases                                                                                                              |
|                      |                                     |                 | 4. Could the passenger flow have introduced bias?                                                                                                                                                                      | High                                                                                                                                                                                   |
| Quarantine           |                                     |                 |                                                                                                                                                                                                                        |                                                                                                                                                                                        |
| Hsieh 2005/Wang 2007 | Domain 1: passenger selection       | A. Risk of bias | 1.1 Was a consecutive or random sample of passengers enrolled?                                                                                                                                                         | <b>Unclear</b>                                                                                                                                                                         |
|                      |                                     |                 | 1.2 Was a case-control design avoided?                                                                                                                                                                                 | <b>yes</b>                                                                                                                                                                             |
|                      |                                     |                 | 1.3 Did the study avoid inappropriate exclusions?                                                                                                                                                                      | <b>Unclear</b>                                                                                                                                                                         |
|                      |                                     |                 | Comments                                                                                                                                                                                                               | It is unclear, if all arriving passengers meeting the quarantine criteria were quarantined, or if there are some form of exclusion criteria Study provides limited information on this |
|                      |                                     |                 | 1. Could the selection of passengers have introduced bias?                                                                                                                                                             | <b>Unclear</b>                                                                                                                                                                         |
|                      | B. Concerns regarding applicability |                 | Describe included passengers (prior testing, presentation, intended use of index test and setting):                                                                                                                    | <b>Real-world intervention</b>                                                                                                                                                         |
|                      |                                     |                 | Is there concern that the included passengers do not match the review question?                                                                                                                                        | <b>Low</b>                                                                                                                                                                             |
|                      | Domain 2: index test(s)             | A. Risk of bias | 2.1 Can we be sure that those identified in index test (true and false positive screening results) were identified by the index test (e.g. automated fever scanner) rather than any other means (e.g. self-reporting)? | <b>N/A</b>                                                                                                                                                                             |
|                      |                                     |                 | 2.2 Were the index test results interpreted without                                                                                                                                                                    | <b>Yes</b>                                                                                                                                                                             |

(Continued)

|                                         |                                     |                                                                                                                                                                          |                                                                                                                                                                                       |
|-----------------------------------------|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                         |                                     | knowledge of the results of the reference standard?                                                                                                                      |                                                                                                                                                                                       |
|                                         |                                     | 2.3 If a threshold was used, was it prespecified?                                                                                                                        | <b>Yes</b>                                                                                                                                                                            |
|                                         |                                     | Comments on risk of bias                                                                                                                                                 | The index test was "being a traveller" or "sitting in proximity to an identified case on the flight".                                                                                 |
|                                         |                                     | 2. Could the conduct or interpretation of the index test have introduced bias?                                                                                           | <b>Low</b>                                                                                                                                                                            |
|                                         | B. Concerns regarding applicability | Describe the index test and how it was conducted and interpreted:                                                                                                        | This is likely how quarantine definitions could look in real-world interventions                                                                                                      |
|                                         |                                     | Is there concern that the index test, its conduct, or interpretation differ from the review question?                                                                    | <b>Low</b>                                                                                                                                                                            |
| Domain 3: reference standard and timing | A. Risk of bias                     | 3.1 Is the reference standard (the approach to identify and classify 'cases') likely to correctly classify the target condition (here active infection with SARS-CoV-2)? | <b>Unclear</b>                                                                                                                                                                        |
|                                         |                                     | 3.2. Were the reference standard results interpreted without knowledge of the results of the index test?                                                                 | No                                                                                                                                                                                    |
|                                         |                                     | Comments on risk of bias                                                                                                                                                 | The study does not provide enough information to evaluate what type of reference test was conducted and how reliable this is                                                          |
|                                         |                                     | 3. Could the reference standard, its conduct, or its interpretation have introduced bias?                                                                                | <b>Unclear</b>                                                                                                                                                                        |
|                                         | B. Concerns regarding applicability | Describe the reference standard and how it was conducted and interpreted:                                                                                                | Limited information available, however <a href="#">Hsieh 2005</a> and <a href="#">Wang 2007</a> provide different figures. It is unclear which of these data points should be trusted |
|                                         |                                     | Is there concern that the target condition as defined by the reference standard does not match the review question?                                                      | <b>High</b>                                                                                                                                                                           |
| Domain 4: flow and timing               | A. Risk of bias                     | 4.1 Did all passengers receive the reference standard?                                                                                                                   | <b>Unclear</b>                                                                                                                                                                        |

(Continued)

|                                                                                                                                                                                   |                                                           |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| 4.2 Did all passengers receive the same reference standard?                                                                                                                       | <b>Unclear</b>                                            |
| 4.3 Were all passengers included in the analysis?<br>Is there likely no or a very low risk of attrition bias?                                                                     | <b>Unclear</b>                                            |
| 4.4 Did the quarantine procedure ensure that further individuals were not infected from being in quarantine? (e.g. additional infections through how the quarantine was handled?) | <b>Unclear</b>                                            |
| Comments on risk of bias                                                                                                                                                          | Limited information is provided on testing and quarantine |
| 4. Could the passenger flow have introduced bias?                                                                                                                                 | <b>Unclear</b>                                            |

**AQIS:** Australian Quarantine and Inspection Service; **CDC:** Centers for Disease Control; **CQO:** Chief Quarantine Officer; **N/A:** not applicable; **RT-PCR:** reverse transcription polymerase chain reaction; **SARS-CoV-2:** severe acute respiratory syndrome coronavirus 2; **WHO:** World Health Organization

## Appendix 8. ROBINS-I risk of bias of observational ecological study

| Study ID | Domain                  | Rating                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Koh 2020 | Bias due to confounding | Potential for confounding? Yes                                                                                                                                                                                                                                                                                                                                                                                                                          |
|          |                         | Appropriate analysis method to control for all the important confounding domains (stratification, regression, matching, standardisation, inverse probability weighting)? No                                                                                                                                                                                                                                                                             |
|          |                         | Confounding domains measured reliably? No                                                                                                                                                                                                                                                                                                                                                                                                               |
|          |                         | Risk of bias Serious                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|          | Comment                 | <ul style="list-style-type: none"> <li>The model does not include the propensity of a country to implement the measures: co-variables other than GDP/population density/temperature and elderly population share are likely to have influenced to have lead to an intervention implementing the measure and could also have led to measures/characteristics reducing (or increasing) the Rt. For example: having experienced a SARS outbreak</li> </ul> |

(Continued)

could have led to an increased willingness of the population to wear masks

- The covariates are used for the whole country. This is inadequate, as the outbreak at 100 cases was confined to a smaller region within a country. For example, if most of the cases occurred in New York City in the USA, taking the average US population density (including states such as Alaska or Kansas) does not match the local risk of an outbreak.
- Also, the timing of the intervention could be biased, depending on the 'pandemic pressure', the number of cases likely to arrive in a country (very high for e.g. UK, very low for Ghana. Here, the timing of co-interventions in other countries play a significant role; in particular the cordon sanitaire around Wuhan

|                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |
|--------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| Bias in selection of participants into the study | Selection based on participants characteristics observed after the start of the intervention?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | No       |
|                                                  | Most participants followed from the start of the intervention?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | No       |
|                                                  | Risk of bias                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Moderate |
| Comment                                          | <p>The 'participants' are 142 countries. The countries were selected based on (1) being a 'country' (which includes e.g. Hong Kong or Guam) and (2) having at least 100 cases (a measure related to the outcome) at day 28 2020. Countries' case data is available from the first official case. The implementation of the measure is available from the start of the intervention. The study differentiates between 'late' and 'early' implementation. 'Early' is defined (for travel restrictions as "1 week before the 100th case". This is for example the case for Iceland, with 13 cases by 28 May.</p> <p>Countries with &lt; 100 cases by 28 May</p> <p>Lesotho 2<br/>Anguilla 3<br/>Western Sahara 6<br/>Bonaire Sint Eustatius and Saba 7<br/>British Virgin Islands 8<br/>Papua New Guinea 8<br/>Montserrat 11<br/>Seychelles 11<br/>Greenland 12<br/>Suriname 12<br/>Turks and Caicos Islands 12<br/>Vatican 12<br/>Falkland Islands 13<br/>Saint Kitts and Nevis 15<br/>Dominica 16<br/>Belize 18<br/>Curacao 18<br/>Fiji 18<br/>New Caledonia 18<br/>Saint Lucia 18</p> |          |

(Continued)

Saint Vincent and the Grenadines 18  
 Laos 19  
 Namibia 22  
 Northern Mariana Islands 22  
 Grenada 23  
 Timor 24  
 Antigua and Barbuda 25  
 Gambia 25  
 Bhutan 28  
 Botswana 35  
 Eritrea 39  
 Burundi 42  
 French Polynesia 60  
 United States Virgin Islands 69  
 Angola 71  
 Sint Maarten (Dutch part) 77  
 Liechtenstein 83  
 Comoros 87  
 Barbados 92  
 Monaco 0 98 +98  
 Libya 99

|                                                    |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------------------------------------------------|------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Bias in classification of interventions            | Intervention groups clearly defined?                                         | No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                                                    | Risk of bias                                                                 | Serious                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                                                    | Comments                                                                     | <p>The countries were classified by the travel-related measures they had implemented into 1 out of 8 categories (none; screening (early/late); quarantine from high-risk regions (early/late), ban on arrivals from some regions (early/late) and total border closure (early/late).</p> <p>Each country could only be classified into 1 category. Although some countries implemented multiple measures (e.g. screening + quarantine as conducted in Taiwan); and others were fairly substantive (border closures were implemented e.g. Germany) are not coded as such.</p> |
| Bias due to deviations from intended interventions | Deviations from intended interventions (e.g. High cross over/drop-out rate)? | No information                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                                                    | Deviations unbalanced between groups?                                        | No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                                                    | Co-interventions balanced across intervention groups?                        | No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                                                    | Risk of bias                                                                 | Serious                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                                                    |                                                                              | <p>The groups were clearly unbalanced</p> <p>For example, late screening was only implemented in 1 country.</p> <p>The countries (and the regions within these heterogeneous countries where the first 100 cases occurred) were clearly different in ways other than the covariates covered as covariates.</p>                                                                                                                                                                                                                                                               |

(Continued)

|                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                           |                |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|----------------|
| Furthermore: the intervention groups are clearly very heterogeneous: e.g. travel restrictions from 'selected regions' are likely to be very different in their effectiveness, if travellers from the 'wrong' country are barred entry.                                                                                                                                                                                                                       |                                                                                           |                |
| Bias due to missing data                                                                                                                                                                                                                                                                                                                                                                                                                                     | Outcome data available for nearly all participants?                                       | Yes            |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Participants excluded due to missing data?                                                | No             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Proportions of participants and reasons for missing data similar across interventions?    | No information |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Results robust? (e.g. Complete-case analysis...)                                          | No information |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Risk of bias                                                                              | Moderate       |
| Data available for all countries with at least 100 cases by 28 May<br>The question is: is there a risk of countries with < 100 cases by 28 May having the potential to introduce bias; e.g. if all countries with < 100 cases all implemented stringent complete border closures?                                                                                                                                                                            |                                                                                           |                |
| Bias in measurement of outcomes                                                                                                                                                                                                                                                                                                                                                                                                                              | Could the outcome measure have been influenced by knowledge of the intervention received? | No             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Were outcome assessors aware of the intervention received by study participants?          | No             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Were the methods of outcome assessment comparable across intervention groups?             | No             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Risk of bias                                                                              | Serious        |
| The countries have different abilities and strategies for testing.<br>If a country only registers cases in the hospital setting (as done in the UK) the number of cases detected is likely lower than in a country in comparison with a comprehensive testing strategy.<br>R(T) calculated on flawed official case numbers has a risk of being distorted, if the ability to test and testing strategy is not balanced adequately across the different groups |                                                                                           |                |

(Continued)

|                                          |                                                          |         |
|------------------------------------------|----------------------------------------------------------|---------|
| Bias in selection of the reported result | Results likely to be selected from multiple measurements | No      |
|                                          | Results likely to be selected from different subgroups   | No      |
|                                          | Risk of bias                                             | Low     |
|                                          | Overall risk of bias                                     | Serious |

**R(T):** current reproduction number

## Appendix 9. Quality assessment of modelling studies

| Study ID      | Domain          |                                                                                                               | Rating                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------|-----------------|---------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Adekunle 2020 | Model structure | 1. Are the structural assumptions transparent and justified?                                                  | Moderate concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|               |                 | 1. Comments                                                                                                   | It is not completely clear what was done. They seem to have built a SEIR model of China or Wuhan<br>Next, a sample of the increasingly infected population flights across the world, using pre-pandemic flight levels until 24 January<br>The model does not allow for infected (to a proportion) not to travel (e.g. for being hospitalized) after a while.<br>They then report to have introduced flight restrictions, but it is not explained how this was done in the model.<br>They report on time until community transmission, but it is not really clear what they did here. |
|               |                 | 2. Are the structural assumptions reasonable given the overall objective, perspective and scope of the model? | Moderate concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|               |                 | 2. Comments                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|               | Input data      | 3. Are the input parameters transparent and justified?                                                        | No to minor concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|               |                 | 3. Comments                                                                                                   | There are references provided for each parameter used in the model                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|               |                 | 4. Are the input parameters reasonable?                                                                       | Moderate concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|               |                 | 4. Comments                                                                                                   | The infectious period of 4 days is rather short. The mortality of 1.8% is likely too high.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

(Continued)

|               |                       |                                                                                                                                                                             |                                                                                                                                                       |
|---------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
|               | Validation (external) | 5. Has an external validation process been described?                                                                                                                       | Reported                                                                                                                                              |
|               |                       | 5. Comments                                                                                                                                                                 | Predicted number of imported cases modelled compared with those observed                                                                              |
|               |                       | 6. Has the model been shown to be externally valid?                                                                                                                         | No to minor concerns                                                                                                                                  |
|               |                       | 6. Comments                                                                                                                                                                 | Predicted number of imported cases is generally consistent with reported number of imported cases                                                     |
|               | Validation (internal) | 7. Has an internal validation process been described?                                                                                                                       | Not reported                                                                                                                                          |
|               |                       | 7. Comments                                                                                                                                                                 | No internal validation conducted                                                                                                                      |
|               |                       | 8. Has the model been shown to be internally valid?                                                                                                                         | Moderate concerns                                                                                                                                     |
|               |                       | 8. Comments                                                                                                                                                                 | No internal validation conducted                                                                                                                      |
|               | Uncertainty           | 9. Was there an adequate assessment of the effects of uncertainty?                                                                                                          | No to minor concerns                                                                                                                                  |
|               |                       | 9. Comments                                                                                                                                                                 |                                                                                                                                                       |
|               | Transparency          | 10. Was technical documentation, in sufficient detail to allow (potentially) for replication, made available openly or under agreements that protect intellectual property? | Moderate concerns                                                                                                                                     |
|               |                       | 10. Comments                                                                                                                                                                | Technical documentation available, code not shared                                                                                                    |
| Anderson 2020 | Model structure       | 1. Are the structural assumptions transparent and justified?                                                                                                                | No to minor concerns                                                                                                                                  |
|               |                       | 1. Comments                                                                                                                                                                 | Well described adapted SEIR Model (SE2IQR) model<br>Travelers are introduced across all stages of infectiousness                                      |
|               |                       | 2. Are the structural assumptions reasonable given the overall objective, perspective and scope of the model?                                                               | Moderate concerns                                                                                                                                     |
|               |                       | 2. Comments                                                                                                                                                                 | Does not allow for asymptomatic infections<br>Developing symptoms does not lead to an increased probability of behaviour change (physical distancing) |

(Continued)

|            |                       |                                                                                                                                                                             |                                                                                                                                                                                                                                                                                        |
|------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|            | Input data            | 3. Are the input parameters transparent and justified?                                                                                                                      | No to minor concerns                                                                                                                                                                                                                                                                   |
|            |                       | 3. Comments                                                                                                                                                                 | All parameters are well justified                                                                                                                                                                                                                                                      |
|            |                       | 4. Are the input parameters reasonable?                                                                                                                                     | Moderate concerns                                                                                                                                                                                                                                                                      |
|            |                       | 4. Comments                                                                                                                                                                 | The incubation period of 1.2 days and the latency period of 0.2 days seem very short; and do not match the cited references. The model assumes that - across the time of infectiousness - only 1/3 of infected are put into quarantine. This figure seems relatively low (but unclear) |
|            | Validation (external) | 5. Has an external validation process been described?                                                                                                                       | Reported                                                                                                                                                                                                                                                                               |
|            |                       | 5. Comments                                                                                                                                                                 | Figure S2: model was fitted against historical model in the 12 regions                                                                                                                                                                                                                 |
|            |                       | 6. Has the model been shown to be externally valid?                                                                                                                         | No to minor concerns                                                                                                                                                                                                                                                                   |
|            |                       | 6. Comments                                                                                                                                                                 | Figure S2: model was fitted against historical model in the 12 regions                                                                                                                                                                                                                 |
|            | Validation (internal) | 7. Has an internal validation process been described?                                                                                                                       | Not reported                                                                                                                                                                                                                                                                           |
|            |                       | 7. Comments                                                                                                                                                                 | No internal validation conducted                                                                                                                                                                                                                                                       |
|            |                       | 8. Has the model been shown to be internally valid?                                                                                                                         | Moderate concerns                                                                                                                                                                                                                                                                      |
|            |                       | 8. Comments                                                                                                                                                                 | No internal validation conducted                                                                                                                                                                                                                                                       |
|            | Uncertainty           | 9. Was there an adequate assessment of the effects of uncertainty?                                                                                                          | Moderate concerns                                                                                                                                                                                                                                                                      |
|            |                       | 9. Comments                                                                                                                                                                 | The model explores the implications of 1 additional case (infected traveller) for an increase in contact rates by factors of 1-2. Other parameters are not varied in the model                                                                                                         |
|            | Transparency          | 10. Was technical documentation, in sufficient detail to allow (potentially) for replication, made available openly or under agreements that protect intellectual property? | No to minor concerns                                                                                                                                                                                                                                                                   |
|            |                       | 10. Comments                                                                                                                                                                | Code to reproduce analysis is provided                                                                                                                                                                                                                                                 |
| Anzai 2020 | Model structure       | 1. Are the structural assumptions transparent and justified?                                                                                                                | Moderate concerns                                                                                                                                                                                                                                                                      |

(Continued)

|            |                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------|---------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|            | 1. Comments                                                                                                   | <p>1. Part 1: reduced number of exported cases: observed cases vs expected number (according to the model) for day 58-day 67 following the lockdown of Wuhan</p> <p>2. Part 2: reduced probability of a major overseas epidemic</p> <p>3. Time delay to a major epidemic gained from the reduction in travel volume</p> <p>The structure of the model is simple; but not well described and not well justified</p>                                                                                                                                                                                                                                                                                                                                                                       |
|            | 2. Are the structural assumptions reasonable given the overall objective, perspective and scope of the model? | Major concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|            | 2. Comments                                                                                                   | <p>Part 1 and also parts 2 and 3 of the model (as these are based on the output of part 1) rely on the number of cases averted by the travel restrictions for the period day 58 to day 67</p> <p>The model is a simple counterfactual model.</p> <p>The interruption is the lockdown of Wuhan, which took place on day 58.</p> <p>The model assumes, that there would have been an exponential growth in cases outside China, if the lockdown had not been initiated, assuming that the exponential growth rate <math>r</math> would have remained constant.</p> <p>This is compared against the observed number of new cases (imported and home grown(?))</p> <p>The difference is attributed to the travel restrictions; primarily attributed to the cordon sanitaire around Wuhan</p> |
|            | 3. Are the input parameters transparent and justified?                                                        | No to minor concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Input data | 3. Comments                                                                                                   | As the assumed model is very simple, the input parameters used are described and justified                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|            | 4. Are the input parameters reasonable?                                                                       | Major concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|            | 4. Comments                                                                                                   | <p>The main input parameter is the exponential growth rate (<math>r</math>). It assumes, that <math>r</math> would remain constant for the period day 58 to day 67 and therefore does not assume any other potential confounders in China (e.g. hygiene, social distancing etc.) and outside China (travel related measures, quarantine of infected would have taken place</p> <p>The model relies on diagnosed cases outside china (using RT-PCR). There is a high likelihood of infected cases missed in this approach</p> <p>The assumptions on the <math>R_0</math> and the dispersion parameters <math>k</math> are justified and reasonable. The assumption of detected cases outside China (day 0-67) however is not, as it is unclear whether these figures are reliable;</p>    |
|            |                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

(Continued)

Additional testing (e.g. of repatriated passengers under quarantine) could have inflated this figure, while insufficient testing or inadequate tests could have led to a significant underestimation of  $h(T)$

|                       |                                                                                                                                                                             |                                                                                                                                                                                                 |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Validation (external) | 5. Has an external validation process been described?                                                                                                                       | Reported                                                                                                                                                                                        |
|                       | 5. Comments                                                                                                                                                                 | Yes, the model has been fitted to data points for day 0-58 outside China                                                                                                                        |
|                       | 6. Has the model been shown to be externally valid?                                                                                                                         | No to minor concerns                                                                                                                                                                            |
|                       | 6. Comments                                                                                                                                                                 | Data points to day 58 were used to fit the Poisson model; and yes, it does fit the model<br>However, these data points are unreliable                                                           |
| Validation (internal) | 7. Has an internal validation process been described?                                                                                                                       | Not reported                                                                                                                                                                                    |
|                       | 7. Comments                                                                                                                                                                 | No internal validation conducted                                                                                                                                                                |
|                       | 8. Has the model been shown to be internally valid?                                                                                                                         | Moderate concerns                                                                                                                                                                               |
|                       | 8. Comments                                                                                                                                                                 | No internal validation conducted                                                                                                                                                                |
| Uncertainty           | 9. Was there an adequate assessment of the effects of uncertainty?                                                                                                          | Moderate concerns                                                                                                                                                                               |
|                       | 9. Comments                                                                                                                                                                 | The model provided a range of sensitivity analysis, e.g. regarding $r$ or on contact tracing. But likely additional sensitivity analysis (e.g. on underestimated cases) would have been helpful |
| Transparency          | 10. Was technical documentation, in sufficient detail to allow (potentially) for replication, made available openly or under agreements that protect intellectual property? | Moderate concerns                                                                                                                                                                               |
|                       | 10. Comments                                                                                                                                                                | Code not available; formulas, input parameters, and program used for calculating the model are described                                                                                        |
| Banholzer 2020        | Model structure                                                                                                                                                             | 1. Are the structural assumptions transparent and justified?                                                                                                                                    |
|                       |                                                                                                                                                                             | 1. Comments                                                                                                                                                                                     |
|                       |                                                                                                                                                                             | 2. Are the structural assumptions reasonable given the overall objective, perspective and scope of the model?                                                                                   |

(Continued)

|                       |                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----------------------|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                       | 2. Comments                                                        | Model assumes equal intervention effectiveness across countries and that interventions have a unique effectiveness independent of time and place in which they are implemented, which is not reasonable, given that a travel ban of different countries (different levels of disease importation pressure) and at different points of time is likely to have a different effect (as the number of imported cases changes with the course of the pandemic around them).<br>It implicitly assumes that all changes in case numbers are due to the intervention (tried to handle with sensitivity analysis) |
| Input data            | 3. Are the input parameters transparent and justified?             | No to minor concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|                       | 3. Comments                                                        | No disease transmission parameters used due to type of model.<br>The model uses data points of cases in the respective countries                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                       | 4. Are the input parameters reasonable?                            | No to minor concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|                       | 4. Comments                                                        | No disease transmission parameters used due to type of model.<br>The model uses data points of cases in the respective countries                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Validation (external) | 5. Has an external validation process been described?              | Reported                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|                       | 5. Comments                                                        | Cross-validation to estimate influence of single countries                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                       | 6. Has the model been shown to be externally valid?                | No to minor concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|                       | 6. Comments                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Validation (internal) | 7. Has an internal validation process been described?              | Not reported                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|                       | 7. Comments                                                        | No internal validation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                       | 8. Has the model been shown to be internally valid?                | Moderate concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|                       | 8. Comments                                                        | No internal validation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Uncertainty           | 9. Was there an adequate assessment of the effects of uncertainty? | No to minor concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|                       | 9. Comments                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

(Continued)

|             |                       |                                                                                                                                                                             |                                                                                                                                |
|-------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
|             | Transparency          | 10. Was technical documentation, in sufficient detail to allow (potentially) for replication, made available openly or under agreements that protect intellectual property? | No to minor concerns                                                                                                           |
|             |                       | 10. Comments                                                                                                                                                                | Code published and extensive supplementary material available                                                                  |
| Boldog 2020 | Model structure       | 1. Are the structural assumptions transparent and justified?                                                                                                                | No to minor concerns                                                                                                           |
|             |                       | 1. Comments                                                                                                                                                                 | Clear and concise description                                                                                                  |
|             |                       | 2. Are the structural assumptions reasonable given the overall objective, perspective and scope of the model?                                                               | No to minor concerns                                                                                                           |
|             |                       | 2. Comments                                                                                                                                                                 |                                                                                                                                |
|             | Input data            | 3. Are the input parameters transparent and justified?                                                                                                                      | No to minor concerns                                                                                                           |
|             |                       | 3. Comments                                                                                                                                                                 | Comprehensive description and justification of input parameters                                                                |
|             |                       | 4. Are the input parameters reasonable?                                                                                                                                     | Moderate concerns                                                                                                              |
|             |                       | 4. Comments                                                                                                                                                                 | Input parameters seem to be reasonable<br>Based on early data<br>Change in R0 in China not adequately represented in the model |
|             | Validation (external) | 5. Has an external validation process been described?                                                                                                                       | Not reported                                                                                                                   |
|             |                       | 5. Comments                                                                                                                                                                 | No external validation was conducted                                                                                           |
|             |                       | 6. Has the model been shown to be externally valid?                                                                                                                         | Moderate concerns                                                                                                              |
|             |                       | 6. Comments                                                                                                                                                                 | No external validation                                                                                                         |
|             | Validation (internal) | 7. Has an internal validation process been described?                                                                                                                       | Not reported                                                                                                                   |
|             |                       | 7. Comments                                                                                                                                                                 | No internal validation conducted                                                                                               |
|             |                       | 8. Has the model been shown to be internally valid?                                                                                                                         | Moderate concerns                                                                                                              |
|             |                       | 8. Comments                                                                                                                                                                 | No internal validation conducted                                                                                               |

(Continued)

|               |                       |                                                                                                                                                                             |                                                                                          |
|---------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
|               | Uncertainty           | 9. Was there an adequate assessment of the effects of uncertainty?                                                                                                          | Moderate concerns                                                                        |
|               |                       | 9. Comments                                                                                                                                                                 | The impact of variation in 3-4 key model parameters on disease outbreak risk is assessed |
|               | Transparency          | 10. Was technical documentation, in sufficient detail to allow (potentially) for replication, made available openly or under agreements that protect intellectual property? | No to minor concerns                                                                     |
|               |                       | 10. Comments                                                                                                                                                                | Comprehensive appendix, source code for the model is available on Github                 |
| Chinazzi 2020 | Model structure       | 1. Are the structural assumptions transparent and justified?                                                                                                                | No to minor concerns                                                                     |
|               |                       | 1. Comments                                                                                                                                                                 |                                                                                          |
|               |                       | 2. Are the structural assumptions reasonable given the overall objective, perspective and scope of the model?                                                               | No to minor concerns                                                                     |
|               |                       | 2. Comments                                                                                                                                                                 |                                                                                          |
|               | Input data            | 3. Are the input parameters transparent and justified?                                                                                                                      | No to minor concerns                                                                     |
|               |                       | 3. Comments                                                                                                                                                                 |                                                                                          |
|               |                       | 4. Are the input parameters reasonable?                                                                                                                                     | Moderate concerns                                                                        |
|               |                       | 4. Comments                                                                                                                                                                 | Based on early data on transmission parameters<br>Broad sensitivity analyses             |
|               | Validation (external) | 5. Has an external validation process been described?                                                                                                                       | Reported                                                                                 |
|               |                       | 5. Comments                                                                                                                                                                 | Limited approach to validate model projections against reported cases                    |
|               |                       | 6. Has the model been shown to be externally valid?                                                                                                                         | Moderate concerns                                                                        |
|               |                       | 6. Comments                                                                                                                                                                 | Limited approach to validate model projections against reported cases                    |
|               | Validation (internal) | 7. Has an internal validation process been described?                                                                                                                       | Not reported                                                                             |
|               |                       | 7. Comments                                                                                                                                                                 | No internal validation described                                                         |

(Continued)

|               |                       |                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                              |
|---------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|               |                       | 8. Has the model been shown to be internally valid?                                                                                                                         | Moderate concerns                                                                                                                                                                                                                                                                                                                                            |
|               |                       | 8. Comments                                                                                                                                                                 | Established model, that is potentially validated, but this is not reported                                                                                                                                                                                                                                                                                   |
|               | Uncertainty           | 9. Was there an adequate assessment of the effects of uncertainty?                                                                                                          | No to minor concerns                                                                                                                                                                                                                                                                                                                                         |
|               |                       | 9. Comments                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                              |
|               | Transparency          | 10. Was technical documentation, in sufficient detail to allow (potentially) for replication, made available openly or under agreements that protect intellectual property? | Moderate concerns                                                                                                                                                                                                                                                                                                                                            |
|               |                       | 10. Comments                                                                                                                                                                | Technical documentation in referenced methods paper; code not available                                                                                                                                                                                                                                                                                      |
| Clifford 2020 | Model structure       | 1. Are the structural assumptions transparent and justified?                                                                                                                | No to minor concerns                                                                                                                                                                                                                                                                                                                                         |
|               |                       | 1. Comments                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                              |
|               |                       | 2. Are the structural assumptions reasonable given the overall objective, perspective and scope of the model?                                                               | No to minor concerns                                                                                                                                                                                                                                                                                                                                         |
|               |                       | 2. Comments                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                              |
|               | Input data            | 3. Are the input parameters transparent and justified?                                                                                                                      | No to minor concerns                                                                                                                                                                                                                                                                                                                                         |
|               |                       | 3. Comments                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                              |
|               |                       | 4. Are the input parameters reasonable?                                                                                                                                     | Major concerns                                                                                                                                                                                                                                                                                                                                               |
|               |                       | 4. Comments                                                                                                                                                                 | Assume an exponential growth rate of $r = 0.1$ corresponding to an epidemic doubling time of 7.4 days based on data on early transmission in Wuhan. Also they assume a fixed travel time of 12 hours<br><br>The assumed sensitivity, cited from <a href="#">Quilty 2020a</a> is questionably high. Quilty data has major concerns regarding input parameters |
|               | Validation (external) | 5. Has an external validation process been described?                                                                                                                       | Not reported                                                                                                                                                                                                                                                                                                                                                 |
|               |                       | 5. Comments                                                                                                                                                                 | No external validation                                                                                                                                                                                                                                                                                                                                       |

(Continued)

|                 |                       |                                                                                                                                                                             |                                                                                                                                                                            |
|-----------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                 |                       | 6. Has the model been shown to be externally valid?                                                                                                                         | Moderate concerns                                                                                                                                                          |
|                 |                       | 6. Comments                                                                                                                                                                 | No external validation                                                                                                                                                     |
|                 | Validation (internal) | 7. Has an internal validation process been described?                                                                                                                       | Not reported                                                                                                                                                               |
|                 |                       | 7. Comments                                                                                                                                                                 | No internal validation                                                                                                                                                     |
|                 |                       | 8. Has the model been shown to be internally valid?                                                                                                                         | Moderate concerns                                                                                                                                                          |
|                 |                       | 8. Comments                                                                                                                                                                 |                                                                                                                                                                            |
|                 | Uncertainty           | 9. Was there an adequate assessment of the effects of uncertainty?                                                                                                          | No to minor concerns                                                                                                                                                       |
|                 |                       | 9. Comments                                                                                                                                                                 | The study authors provide an App which allows readers to assess the sensitivity of results to many parameter assumptions                                                   |
|                 | Transparency          | 10. Was technical documentation, in sufficient detail to allow (potentially) for replication, made available openly or under agreements that protect intellectual property? | No to minor concerns                                                                                                                                                       |
|                 |                       | 10. Comments                                                                                                                                                                | Code available on GitHub                                                                                                                                                   |
| Costantino 2020 | Model structure       | 1. Are the structural assumptions transparent and justified?                                                                                                                | No to minor concerns                                                                                                                                                       |
|                 |                       | 1. Comments                                                                                                                                                                 |                                                                                                                                                                            |
|                 |                       | 2. Are the structural assumptions reasonable given the overall objective, perspective and scope of the model?                                                               | Major concerns                                                                                                                                                             |
|                 |                       | 2. Comments                                                                                                                                                                 | The model does not consider other influencing factors e.g. the cordon sanitaire around Wuhan as a reason for the difference and attributes it to the Australian travel ban |
|                 | Input data            | 3. Are the input parameters transparent and justified?                                                                                                                      | No to minor concerns                                                                                                                                                       |
|                 |                       | 3. Comments                                                                                                                                                                 |                                                                                                                                                                            |
|                 |                       | 4. Are the input parameters reasonable?                                                                                                                                     | Moderate concerns                                                                                                                                                          |
|                 |                       | 4. Comments                                                                                                                                                                 | Input parameters seem to be reasonable <ul style="list-style-type: none"> <li>The mortality is relatively high</li> </ul>                                                  |

(Continued)

- The assumptions on detected and isolated cases relatively low

|                       |                                                                                                                                                                             |                                                                                                                                        |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| Validation (external) | 5. Has an external validation process been described?                                                                                                                       | Reported                                                                                                                               |
|                       | 5. Comments                                                                                                                                                                 | The estimated incidence data in China was compared to the observed incidence data; no other external validation was done               |
|                       | 6. Has the model been shown to be externally valid?                                                                                                                         | Moderate concerns                                                                                                                      |
|                       | 6. Comments                                                                                                                                                                 | Limited approach to validate model projections against reported cases                                                                  |
| Validation (internal) | 7. Has an internal validation process been described?                                                                                                                       | Not reported                                                                                                                           |
|                       | 7. Comments                                                                                                                                                                 | No internal validation                                                                                                                 |
|                       | 8. Has the model been shown to be internally valid?                                                                                                                         | Moderate concerns                                                                                                                      |
|                       | 8. Comments                                                                                                                                                                 | No internal validation                                                                                                                 |
| Uncertainty           | 9. Was there an adequate assessment of the effects of uncertainty?                                                                                                          | No to minor concerns                                                                                                                   |
|                       | 9. Comments                                                                                                                                                                 | A broad range of sensitivity analyses with alternative assumptions of different input parameters was done                              |
| Transparency          | 10. Was technical documentation, in sufficient detail to allow (potentially) for replication, made available openly or under agreements that protect intellectual property? | Moderate concerns                                                                                                                      |
|                       | 10. Comments                                                                                                                                                                | Supplementary material with further details of the model is supposed to be available, but this cannot be opened; code is not available |
| Model structure       | 1. Are the structural assumptions transparent and justified?                                                                                                                | No to minor concerns                                                                                                                   |
|                       | 1. Comments                                                                                                                                                                 |                                                                                                                                        |
|                       | 2. Are the structural assumptions reasonable given the overall objective, perspective and scope of the model?                                                               | No to minor concerns                                                                                                                   |
|                       | 2. Comments                                                                                                                                                                 |                                                                                                                                        |

(Continued)

|             |                       |                                                                                                                                                                             |                                                                                                            |
|-------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
|             | Input data            | 3. Are the input parameters transparent and justified?                                                                                                                      | Moderate concerns                                                                                          |
|             |                       | 3. Comments                                                                                                                                                                 | For some of the parameters no empirical data or justification was available                                |
|             |                       | 4. Are the input parameters reasonable?                                                                                                                                     | No to minor concerns                                                                                       |
|             |                       | 4. Comments                                                                                                                                                                 | Input parameters seem to be reasonable                                                                     |
|             | Validation (external) | 5. Has an external validation process been described?                                                                                                                       | Not reported                                                                                               |
|             |                       | 5. Comments                                                                                                                                                                 | No external validation was conducted                                                                       |
|             |                       | 6. Has the model been shown to be externally valid?                                                                                                                         | Moderate concerns                                                                                          |
|             |                       | 6. Comments                                                                                                                                                                 | No external validation                                                                                     |
|             | Validation (internal) | 7. Has an internal validation process been described?                                                                                                                       | Not reported                                                                                               |
|             |                       | 7. Comments                                                                                                                                                                 | Model describes hypothetical if-then scenarios using a range of input parameters                           |
|             |                       | 8. Has the model been shown to be internally valid?                                                                                                                         | Moderate concerns                                                                                          |
|             |                       | 8. Comments                                                                                                                                                                 | Model describes hypothetical if-then scenarios using a range of input parameters                           |
|             | Uncertainty           | 9. Was there an adequate assessment of the effects of uncertainty?                                                                                                          | No to minor concerns                                                                                       |
|             |                       | 9. Comments                                                                                                                                                                 | A broad range of sensitivity analyses with alternative assumptions of different input parameters were done |
|             | Transparency          | 10. Was technical documentation, in sufficient detail to allow (potentially) for replication, made available openly or under agreements that protect intellectual property? | Moderate concerns                                                                                          |
|             |                       | 10. Comments                                                                                                                                                                | Appendix shows details on model calculations; no code is available                                         |
| Gostic 2015 | Model structure       | 1. Are the structural assumptions transparent and justified?                                                                                                                | No to minor concerns                                                                                       |
|             |                       | 1. Comments                                                                                                                                                                 |                                                                                                            |
|             |                       | 2. Are the structural assumptions reasonable given the over-                                                                                                                | Moderate concerns                                                                                          |

(Continued)

|                       |                                                        |                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------|--------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                       | all objective, perspective and scope of the model?     |                                                                                                                                                                                                                                                                                                                                                                                            |
|                       | 2. Comments                                            | Model assumes two modes of screening (self-reporting/symptom screening) at arrival and departure, assuming the sensitivity of the scanners, the awareness about exposure, and the willingness to report symptoms.<br>The structural assumptions are reasonable, however the assumption, that infected people are removed from the population and not able to travel, seems quite arbitrary |
| Input data            | 3. Are the input parameters transparent and justified? | Moderate concerns                                                                                                                                                                                                                                                                                                                                                                          |
|                       | 3. Comments                                            | Study authors provide references for most parameters, however only one reference for most parameters is provided.<br>The parameters of willingness to report exposure are assumed                                                                                                                                                                                                          |
|                       | 4. Are the input parameters reasonable?                | Moderate concerns                                                                                                                                                                                                                                                                                                                                                                          |
|                       | 4. Comments                                            | The travel time of 24 h hours seems to be rather long<br>The assumption that infected people are removed from the population and not able to travel seems quite arbitrary and - given that 30 are asymptomatic - the likelihood of 100% quarantine after 3-7 days is not reasonable                                                                                                        |
| Validation (external) | 5. Has an external validation process been described?  | Not reported                                                                                                                                                                                                                                                                                                                                                                               |
|                       | 5. Comments                                            | No formal external validation conducted<br>However the results of the study are discussed in the light of findings of empirical studies coming to similar conclusions. But this discussion is very limited in regards to empirical studies on SARS where there are empirical studies available, and is general, rather than specifically focused on their findings                         |
|                       | 6. Has the model been shown to be externally valid?    | Moderate concerns                                                                                                                                                                                                                                                                                                                                                                          |
|                       | 6. Comments                                            | No external validation                                                                                                                                                                                                                                                                                                                                                                     |
| Validation (internal) | 7. Has an internal validation process been described?  | Not reported                                                                                                                                                                                                                                                                                                                                                                               |
|                       | 7. Comments                                            | No internal validation                                                                                                                                                                                                                                                                                                                                                                     |
|                       | 8. Has the model been shown to be internally valid?    | Moderate concerns                                                                                                                                                                                                                                                                                                                                                                          |
|                       | 8. Comments                                            | No internal validation                                                                                                                                                                                                                                                                                                                                                                     |

(Continued)

|             |                 |                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Gostic 2020 | Uncertainty     | 9. Was there an adequate assessment of the effects of uncertainty?                                                                                                          | No to minor concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|             |                 | 9. Comments                                                                                                                                                                 | Various sensitivity analyses were conducted to assess various parameters; the main parameter: number of asymptomatic cases is estimated to be 5%, 25%, and 50%                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|             | Transparency    | 10. Was technical documentation, in sufficient detail to allow (potentially) for replication, made available openly or under agreements that protect intellectual property? | No to minor concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|             |                 | 10. Comments                                                                                                                                                                | Code available                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|             | Model structure | 1. Are the structural assumptions transparent and justified?                                                                                                                | No to minor concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|             |                 | 1. Comments                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|             |                 | 2. Are the structural assumptions reasonable given the overall objective, perspective and scope of the model?                                                               | Moderate concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|             |                 | 2. Comments                                                                                                                                                                 | Model assumes two modes of screening (self-reporting/symptom screening) at arrival and departure, assuming the sensitivity of the scanners, the awareness about exposure, and the willingness to report symptoms. They furthermore assume that passengers after a time period are being isolated/hospitalized in the departure country. The structural assumptions are reasonable, however the assumption, that infected are removed from the population and not able to travel seems quite arbitrary and - given that 30 are asymptomatic - the likelihood of 100% quarantine after 3-7 days is not reasonable |
|             | Input data      | 3. Are the input parameters transparent and justified?                                                                                                                      | No to minor concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|             |                 | 3. Comments                                                                                                                                                                 | Study authors provide references for most parameters<br>The parameters of awareness are assumed                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|             |                 | 4. Are the input parameters reasonable?                                                                                                                                     | Moderate concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|             |                 | 4. Comments                                                                                                                                                                 | The travel time of 24 h hours seems to be rather long<br>The assumption that infected people are removed from the population and not able to travel seems quite arbitrary and - given that 30 are asymptomatic -                                                                                                                                                                                                                                                                                                                                                                                                |

(Continued)

|                       |                                                                                                                                                                             |                                                                                                                                                                      |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                       |                                                                                                                                                                             | matic - the likelihood of 100% quarantine after 3-7 days is not reasonable                                                                                           |
| Validation (external) | 5. Has an external validation process been described?                                                                                                                       | Not reported                                                                                                                                                         |
|                       | 5. Comments                                                                                                                                                                 | No formal external validation conducted, however the results of the study are discussed in the light of findings of empirical studies coming to similar conclusions. |
|                       | 6. Has the model been shown to be externally valid?                                                                                                                         | Moderate concerns                                                                                                                                                    |
|                       | 6. Comments                                                                                                                                                                 | No formal external validation conducted; however the results of the study are discussed in the light of findings of empirical studies coming to similar conclusions. |
| Validation (internal) | 7. Has an internal validation process been described?                                                                                                                       | Not reported                                                                                                                                                         |
|                       | 7. Comments                                                                                                                                                                 | No internal validation                                                                                                                                               |
|                       | 8. Has the model been shown to be internally valid?                                                                                                                         | Moderate concerns                                                                                                                                                    |
|                       | 8. Comments                                                                                                                                                                 | No internal validation                                                                                                                                               |
| Uncertainty           | 9. Was there an adequate assessment of the effects of uncertainty?                                                                                                          | No to minor concerns                                                                                                                                                 |
|                       | 9. Comments                                                                                                                                                                 | Various sensitivity analyses were conducted to assess various parameters; the main parameter: number of asymptomatic cases is estimated to be 5%, 25%, and 50%       |
| Transparency          | 10. Was technical documentation, in sufficient detail to allow (potentially) for replication, made available openly or under agreements that protect intellectual property? | No to minor concerns                                                                                                                                                 |
|                       | 10. Comments                                                                                                                                                                | Code available                                                                                                                                                       |
| Goubar 2009           | Model structure                                                                                                                                                             | 1. Are the structural assumptions transparent and justified?                                                                                                         |
|                       |                                                                                                                                                                             | 1. Comments                                                                                                                                                          |
|                       |                                                                                                                                                                             | 2. Are the structural assumptions reasonable given the overall objective, perspective and scope of the model?                                                        |
|                       |                                                                                                                                                                             | 2. Comments                                                                                                                                                          |
|                       |                                                                                                                                                                             | No to minor concerns                                                                                                                                                 |
|                       |                                                                                                                                                                             | Moderate concerns                                                                                                                                                    |
|                       |                                                                                                                                                                             | Assumption that all infected individuals can travel is questionable                                                                                                  |

(Continued)

|                       |                                                                                                                                                                             |                                                                                                                                                                                                              |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                       |                                                                                                                                                                             | Only direct flights were considered, though it is likely that there are countless indirect connections between these two sets of large, populous cities                                                      |
| Input data            | 3. Are the input parameters transparent and justified?                                                                                                                      | No to minor concerns                                                                                                                                                                                         |
|                       | 3. Comments                                                                                                                                                                 | Reported in Table 1 of the paper; citations provided for each                                                                                                                                                |
|                       | 4. Are the input parameters reasonable?                                                                                                                                     | No to minor concerns                                                                                                                                                                                         |
|                       | 4. Comments                                                                                                                                                                 | Input parameters seem to be reasonable                                                                                                                                                                       |
| Validation (external) | 5. Has an external validation process been described?                                                                                                                       | Reported                                                                                                                                                                                                     |
|                       | 5. Comments                                                                                                                                                                 | Model fit to cumulative cases in Hong Kong over study period                                                                                                                                                 |
|                       | 6. Has the model been shown to be externally valid?                                                                                                                         | No to minor concerns                                                                                                                                                                                         |
|                       | 6. Comments                                                                                                                                                                 | Over most of the study period (except for one week) the model results fit the cumulative number of cases well; even with the discrepancy, the study authors write that the conclusions would remain the same |
| Validation (internal) | 7. Has an internal validation process been described?                                                                                                                       | Not reported                                                                                                                                                                                                 |
|                       | 7. Comments                                                                                                                                                                 | No internal validation                                                                                                                                                                                       |
|                       | 8. Has the model been shown to be internally valid?                                                                                                                         | Moderate concerns                                                                                                                                                                                            |
|                       | 8. Comments                                                                                                                                                                 | No internal validation                                                                                                                                                                                       |
| Uncertainty           | 9. Was there an adequate assessment of the effects of uncertainty?                                                                                                          | Moderate concerns                                                                                                                                                                                            |
|                       | 9. Comments                                                                                                                                                                 | An assessment of two varying scenarios of screening sensitivity, however no further analyses                                                                                                                 |
| Transparency          | 10. Was technical documentation, in sufficient detail to allow (potentially) for replication, made available openly or under agreements that protect intellectual property? | Moderate concerns                                                                                                                                                                                            |
|                       | 10. Comments                                                                                                                                                                | Appendix shows details on model calculations; no code is available                                                                                                                                           |

(Continued)

Gumel 2004

|                       |                                                                                                               |                                                                                                                                                                                                                                                                                  |
|-----------------------|---------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Model structure       | 1. Are the structural assumptions transparent and justified?                                                  | No to minor concerns                                                                                                                                                                                                                                                             |
|                       | 1. Comments                                                                                                   | It is a simple and well discussed/described SEIR+ model                                                                                                                                                                                                                          |
|                       | 2. Are the structural assumptions reasonable given the overall objective, perspective and scope of the model? | No to minor concerns                                                                                                                                                                                                                                                             |
|                       | 2. Comments                                                                                                   | It is a simple and well discussed/described SEIR+ model                                                                                                                                                                                                                          |
| Input data            | 3. Are the input parameters transparent and justified?                                                        | No to minor concerns                                                                                                                                                                                                                                                             |
|                       | 3. Comments                                                                                                   | Study describes the parameters and provides references for the assumptions                                                                                                                                                                                                       |
|                       | 4. Are the input parameters reasonable?                                                                       | No to minor concerns                                                                                                                                                                                                                                                             |
|                       | 4. Comments                                                                                                   | The parameters seem to be reasonable.                                                                                                                                                                                                                                            |
| Validation (external) | 5. Has an external validation process been described?                                                         | Reported                                                                                                                                                                                                                                                                         |
|                       | 5. Comments                                                                                                   | For Toronto (where the travel-related intervention is part of the model) an external validation against 3 other regions (Singapore, Beijing, Hong Kong) for cases and mortality was conducted                                                                                    |
|                       | 6. Has the model been shown to be externally valid?                                                           | Moderate concerns                                                                                                                                                                                                                                                                |
|                       | 6. Comments                                                                                                   | Regarding the cumulative number of deaths (outcome of interest for the travel-related intervention) the model fits very well for Singapore, but does not match the timing of the course in Beijing and underestimates the plateau; and underestimates the plateau for Hong Kong. |
| Validation (internal) | 7. Has an internal validation process been described?                                                         | Not reported                                                                                                                                                                                                                                                                     |
|                       | 7. Comments                                                                                                   | No internal validation conducted                                                                                                                                                                                                                                                 |
|                       | 8. Has the model been shown to be internally valid?                                                           | Moderate concerns                                                                                                                                                                                                                                                                |
|                       | 8. Comments                                                                                                   | No internal validation conducted                                                                                                                                                                                                                                                 |
| Uncertainty           | 9. Was there an adequate assessment of the effects of uncertainty?                                            | Moderate concerns                                                                                                                                                                                                                                                                |
|                       | 9. Comments                                                                                                   | Yes for the model overall                                                                                                                                                                                                                                                        |

(Continued)

However, as the change in the influx in infected passengers is a sub-analysis in itself, limited variation is conducted here.

|            |                       |                                                                                                                                                                             |                                                                                                                                                                                               |
|------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|            | Transparency          | 10. Was technical documentation, in sufficient detail to allow (potentially) for replication, made available openly or under agreements that protect intellectual property? | Moderate concerns                                                                                                                                                                             |
|            |                       | 10. Comments                                                                                                                                                                | Code not available; the SEIR model and the input parameters are well described and it should be possible to replicate the analysis                                                            |
| Hsieh 2007 | Model structure       | 1. Are the structural assumptions transparent and justified?                                                                                                                | No to minor concerns                                                                                                                                                                          |
|            |                       | 1. Comments                                                                                                                                                                 | Expanded well described SEIR model<br>Infected, quarantined Infected and hospitalized are infectious<br>Allows for imported cases to enter the population (un-quarantined or in quarantine B) |
|            |                       | 2. Are the structural assumptions reasonable given the overall objective, perspective and scope of the model?                                                               | Moderate concerns                                                                                                                                                                             |
|            |                       | 2. Comments                                                                                                                                                                 | The model does not allow for asymptomatic infected; however, with SARS, this seems to be of less significance as with SARS-CoV-2                                                              |
|            | Input data            | 3. Are the input parameters transparent and justified?                                                                                                                      | No to minor concerns                                                                                                                                                                          |
|            |                       | 3. Comments                                                                                                                                                                 | All parameters are well described and references are provided for the parameters                                                                                                              |
|            |                       | 4. Are the input parameters reasonable?                                                                                                                                     | No to minor concerns                                                                                                                                                                          |
|            |                       | 4. Comments                                                                                                                                                                 | All described parameters appear to be reasonable                                                                                                                                              |
|            | Validation (external) | 5. Has an external validation process been described?                                                                                                                       | Reported                                                                                                                                                                                      |
|            |                       | 5. Comments                                                                                                                                                                 | The model and the parameters included in it were developed based on data of cases in Taiwan. A formal validation process is not described                                                     |
|            |                       | 6. Has the model been shown to be externally valid?                                                                                                                         | Moderate concerns                                                                                                                                                                             |
|            |                       | 6. Comments                                                                                                                                                                 | Model is fitted against the case data available, however, this provides very few data points (e.g. 1 person quarantined)                                                                      |

(Continued)

|                             |                       |                                                                                                                                                                             |                                                                                                                                                                                                                                                                                     |
|-----------------------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                             | Validation (internal) | 7. Has an internal validation process been described?                                                                                                                       | Not reported                                                                                                                                                                                                                                                                        |
|                             |                       | 7. Comments                                                                                                                                                                 | No internal validation                                                                                                                                                                                                                                                              |
|                             |                       | 8. Has the model been shown to be internally valid?                                                                                                                         | Moderate concerns                                                                                                                                                                                                                                                                   |
|                             |                       | 8. Comments                                                                                                                                                                 | No internal validation                                                                                                                                                                                                                                                              |
|                             | Uncertainty           | 9. Was there an adequate assessment of the effects of uncertainty?                                                                                                          | No to minor concerns                                                                                                                                                                                                                                                                |
|                             |                       | 9. Comments                                                                                                                                                                 | The model plays through a number of assumption regarding the level B quarantine; (however less so with other parameters)                                                                                                                                                            |
|                             | Transparency          | 10. Was technical documentation, in sufficient detail to allow (potentially) for replication, made available openly or under agreements that protect intellectual property? | Moderate concerns                                                                                                                                                                                                                                                                   |
|                             |                       | 10. Comments                                                                                                                                                                | Code not available; the SEIR model and the input parameters are well described and it should be possible to replicate the analysis                                                                                                                                                  |
| <a href="#">Linka 2020a</a> | Model structure       | 1. Are the structural assumptions transparent and justified?                                                                                                                | No to minor concerns                                                                                                                                                                                                                                                                |
|                             |                       | 1. Comments                                                                                                                                                                 |                                                                                                                                                                                                                                                                                     |
|                             |                       | 2. Are the structural assumptions reasonable given the overall objective, perspective and scope of the model?                                                               | Moderate concerns                                                                                                                                                                                                                                                                   |
|                             |                       | 2. Comments                                                                                                                                                                 | The study authors assume that the number of infections are equal to the difference between the confirmed cases and the recovered cases and deaths from data from the ECDC; this assumption is not very reasonable as the reporting of recovered cases is unreliable and incomplete. |
|                             | Input data            | 3. Are the input parameters transparent and justified?                                                                                                                      | No to minor concerns                                                                                                                                                                                                                                                                |
|                             |                       | 3. Comments                                                                                                                                                                 |                                                                                                                                                                                                                                                                                     |
|                             |                       | 4. Are the input parameters reasonable?                                                                                                                                     | Moderate concerns                                                                                                                                                                                                                                                                   |
|                             |                       | 4. Comments                                                                                                                                                                 | Based on data on the latent and infectious periods $A \frac{1}{4} 1 = a \frac{1}{4} 2.56$ days and $C \frac{1}{4} 1 = c \frac{1}{4} 17.82$ days from 30 Chinese provinces (Peirlinck 2020).                                                                                         |

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|                       |                                                                                                                                                                             | Yields estimates for R0 of 8.7 in Austria and 6.0 in Germany                                                  |                                                                                                                                                                                                                    |
| Validation (external) | 5. Has an external validation process been described?                                                                                                                       | Reported                                                                                                      |                                                                                                                                                                                                                    |
|                       | 5. Comments                                                                                                                                                                 | Limited approach to validate model projections against data used to build the model                           |                                                                                                                                                                                                                    |
|                       | 6. Has the model been shown to be externally valid?                                                                                                                         | Moderate concerns                                                                                             |                                                                                                                                                                                                                    |
|                       | 6. Comments                                                                                                                                                                 | Simulated data seem to be quite far from the observed data (see Figure 2)                                     |                                                                                                                                                                                                                    |
| Validation (internal) | 7. Has an internal validation process been described?                                                                                                                       | Not reported                                                                                                  |                                                                                                                                                                                                                    |
|                       | 7. Comments                                                                                                                                                                 | No internal validation                                                                                        |                                                                                                                                                                                                                    |
|                       | 8. Has the model been shown to be internally valid?                                                                                                                         | Moderate concerns                                                                                             |                                                                                                                                                                                                                    |
|                       | 8. Comments                                                                                                                                                                 | No internal validation                                                                                        |                                                                                                                                                                                                                    |
| Uncertainty           | 9. Was there an adequate assessment of the effects of uncertainty?                                                                                                          | Major concerns                                                                                                |                                                                                                                                                                                                                    |
|                       | 9. Comments                                                                                                                                                                 | No sensitivity analyses or other assessments of uncertainty                                                   |                                                                                                                                                                                                                    |
| Transparency          | 10. Was technical documentation, in sufficient detail to allow (potentially) for replication, made available openly or under agreements that protect intellectual property? | Moderate concerns                                                                                             |                                                                                                                                                                                                                    |
|                       | 10. Comments                                                                                                                                                                | Code not available                                                                                            |                                                                                                                                                                                                                    |
| Mandal 2020           | Model structure                                                                                                                                                             | 1. Are the structural assumptions transparent and justified?                                                  | No to minor concerns                                                                                                                                                                                               |
|                       |                                                                                                                                                                             | 1. Comments                                                                                                   |                                                                                                                                                                                                                    |
|                       |                                                                                                                                                                             | 2. Are the structural assumptions reasonable given the overall objective, perspective and scope of the model? | Major concerns                                                                                                                                                                                                     |
|                       |                                                                                                                                                                             | 2. Comments                                                                                                   | The study authors assume that all infections go through an asymptomatic stage and a symptomatic stage; they assume that the exposed are infected from the start (but with less severity as when showing symptoms). |

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|                       |                                                                                                                                                                             | The model does somewhat mix the incubation period and the asymptomatic cases into one mixed stage                                                                                                                                                                                                                                                                              |
| Input data            | 3. Are the input parameters transparent and justified?                                                                                                                      | Moderate concerns                                                                                                                                                                                                                                                                                                                                                              |
|                       | 3. Comments                                                                                                                                                                 | It is unclear how the study authors determine the parameters of their SIR model concerning recovery and death and the parameter values are not given. The study authors assume that asymptomatic cases are only 0.1 or 0.5 times as infectious as symptomatic cases but do not give any references for these assumptions.                                                      |
|                       | 4. Are the input parameters reasonable?                                                                                                                                     | Major concerns                                                                                                                                                                                                                                                                                                                                                                 |
|                       | 4. Comments                                                                                                                                                                 | The study authors assume that all symptomatic COVID-19 cases are identified and that 0%, 50%, or 90% of asymptomatic cases are identified. These values seem very optimistic (other authors, for instance <a href="#">Clifford 2020</a> or <a href="#">Gostic 2015</a> assume more realistic and justified parameter values concerning the sensitivity of screening measures). |
| Validation (external) | 5. Has an external validation process been described?                                                                                                                       | Not reported                                                                                                                                                                                                                                                                                                                                                                   |
|                       | 5. Comments                                                                                                                                                                 | No external validation                                                                                                                                                                                                                                                                                                                                                         |
|                       | 6. Has the model been shown to be externally valid?                                                                                                                         | Moderate concerns                                                                                                                                                                                                                                                                                                                                                              |
|                       | 6. Comments                                                                                                                                                                 | No external validation                                                                                                                                                                                                                                                                                                                                                         |
| Validation (internal) | 7. Has an internal validation process been described?                                                                                                                       | Not reported                                                                                                                                                                                                                                                                                                                                                                   |
|                       | 7. Comments                                                                                                                                                                 | No internal validation                                                                                                                                                                                                                                                                                                                                                         |
|                       | 8. Has the model been shown to be internally valid?                                                                                                                         | Moderate concerns                                                                                                                                                                                                                                                                                                                                                              |
|                       | 8. Comments                                                                                                                                                                 | No internal validation                                                                                                                                                                                                                                                                                                                                                         |
| Uncertainty           | 9. Was there an adequate assessment of the effects of uncertainty?                                                                                                          | Moderate concerns                                                                                                                                                                                                                                                                                                                                                              |
|                       | 9. Comments                                                                                                                                                                 | Limited sensitivity analyses on a few parameters                                                                                                                                                                                                                                                                                                                               |
| Transparency          | 10. Was technical documentation, in sufficient detail to allow (potentially) for replication, made available openly or under agreements that protect intellectual property? | Moderate concerns                                                                                                                                                                                                                                                                                                                                                              |

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|---------------|-----------------|---------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|               |                 | 10. Comments                                                                                                  | Model formulae available but from my point of view, it is not very clear how the authors calibrated their SIR model. No code available                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Odendaal 2020 | Model structure | 1. Are the structural assumptions transparent and justified?                                                  | Moderate concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|               |                 | 1. Comments                                                                                                   | Model intends to describe the impact of the travel restrictions in the USA on 31 January (the interruption).<br>It uses an exponential form to describe the cases outside China (as cases in China are considered unreliable)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|               |                 | 2. Are the structural assumptions reasonable given the overall objective, perspective and scope of the model? | Major concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|               |                 | 2. Comments                                                                                                   | It is a very simple model that intends to describe the impact of the travel restrictions in the USA on 31 January (the interruption).<br>It uses a simple exponential form to describe the cases outside China (as cases in China are considered unreliable). It finds that the number of cases (largely) follows an exponential growth rate (data fits better starting from mid-February).<br>The model actually does not predict the impact of the US travel restriction.<br>The model does not conclude that the 26-day delay of community spread (the start of the exponential growth in the USA) was caused by the US travel restrictions. They actually just postulate this:<br>Observation 1: community spread started around 26 of February (debatable, but okay) → starting here, the official number of cases in the USA follows an exponential growth<br>Observation 2: the number of cases outside China largely follows an exponential growth rate<br>Observation 3: the time between the implementation of the US travel restrictions (31 January) and the beginning of community spread in the USA is about 26 days.<br>Conclusion: "The imposition of early travel restrictions from China into the USA slowed down the virus by containing it mainly to individuals who had been to infected areas. The model indicates that delay was 26 days before it became "community-spread" in the USA.<br>A main issue in this model is that it does not account for other confounders here.<br>In particular: the cordon sanitaire around Wuhan on the 23 of January.<br>It does not take travel patterns into account → it does not take the probability of seeding (regular travel patterns) into account.<br>There is no causal inference; the 26 days are observed; not results from the model |

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| Input data            | 3. Are the input parameters transparent and justified?             | No to minor concerns                                                                                                                                                                                                                                                                                                                                                                                |
|                       | 3. Comments                                                        | The parameters of the exponential growth model are derived from the official number of cases outside China. This is well justified and reported; the parameters for the exponential growth rates are given and justified<br>The start of the community spread is based on official numbers in the USA; the parameters for the exponential growth rate (starting around 29) in the USA are justified |
|                       | 4. Are the input parameters reasonable?                            | No to minor concerns                                                                                                                                                                                                                                                                                                                                                                                |
|                       | 4. Comments                                                        | These parameters seem to be reasonable                                                                                                                                                                                                                                                                                                                                                              |
| Validation (external) | 5. Has an external validation process been described?              | Reported                                                                                                                                                                                                                                                                                                                                                                                            |
|                       | 5. Comments                                                        | The model for the exponential growth of global cases is based on exported cases; model checked against these figures.<br>No external validation specific to the outcome of interest "delay of community spread was conducted"                                                                                                                                                                       |
|                       | 6. Has the model been shown to be externally valid?                | Moderate concerns                                                                                                                                                                                                                                                                                                                                                                                   |
|                       | 6. Comments                                                        | The model for the exponential growth of global cases is based on exported cases.<br>However, their model only starts to fit these figures starting from around mid-February.<br>The 'global model' is not fitted against the US figures, rather, it reports that there is exponential growth starting around end of February as well.                                                               |
| Validation (internal) | 7. Has an internal validation process been described?              | Not reported                                                                                                                                                                                                                                                                                                                                                                                        |
|                       | 7. Comments                                                        | No internal validation conducted                                                                                                                                                                                                                                                                                                                                                                    |
|                       | 8. Has the model been shown to be internally valid?                | Moderate concerns                                                                                                                                                                                                                                                                                                                                                                                   |
|                       | 8. Comments                                                        | No internal validation conducted                                                                                                                                                                                                                                                                                                                                                                    |
| Uncertainty           | 9. Was there an adequate assessment of the effects of uncertainty? | Major concerns                                                                                                                                                                                                                                                                                                                                                                                      |
|                       | 9. Comments                                                        | The study does not assess uncertainties and does not take other explanations into account                                                                                                                                                                                                                                                                                                           |
| Transparency          | 10. Was technical documentation, in sufficient detail to al-       | Moderate concerns                                                                                                                                                                                                                                                                                                                                                                                   |

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|              |                       | low (potentially) for replication, made available openly or under agreements that protect intellectual property? |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|              |                       | 10. Comments                                                                                                     | Code not available; the model and the input parameters are given and it should be possible to replicate the analysis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Quilty 2020a | Model structure       | 1. Are the structural assumptions transparent and justified?                                                     | No to minor concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|              |                       | 1. Comments                                                                                                      | The model is adequately described                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|              |                       | 2. Are the structural assumptions reasonable given the overall objective, perspective and scope of the model?    | Moderate concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|              |                       | 2. Comments                                                                                                      | The model assumes 2 types of infections: asymptomatic and symptomatic of which 100% will experience a worsening of symptoms after 9.1 (+/- 14 days). It is unreasonable to assume that all passengers will be hospitalized. It could however be assumed, that a share of those experiencing symptoms will decide not to travel; however it is unclear, why this should take place after 9.1 days. Furthermore, the study does not allow for self-reporting of symptoms but relies on the thermal scanners for detection.                                                                                                                                                                               |
|              | Input data            | 3. Are the input parameters transparent and justified?                                                           | No to minor concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|              |                       | 3. Comments                                                                                                      | The study provides references almost all input parameters                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|              |                       | 4. Are the input parameters reasonable?                                                                          | Major concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|              |                       | 4. Comments                                                                                                      | The study assumes that 83% of infected people will develop symptoms. In the light of the current evidence, this figure seems to be too high. The model assumes, that 100% of the passengers will develop fever, which is not the case (there are infections that are symptomatic but do not have fever or only elevated temperature below the level to be detected by the thermal scanners. The sensitivity of the scanners was assumed to be 86%. In the study referenced, the value is given as 0.86% (95% CI 0.75 to 0.97) for a temperature of 37.8 °C. The assumption of 100% of symptomatic infected people will refrain from travelling after mean 9.1 days (+/- 14.7 days) is likely too high. |
|              | Validation (external) | 5. Has an external validation process been described?                                                            | Not reported                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

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|----------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |                       | 5. Comments                                                                                                                                                                 | No external validation was conducted<br>The study does not discuss the findings in the light of empirical studies assessing screening interventions or the findings from repatriation studies         |
|          |                       | 6. Has the model been shown to be externally valid?                                                                                                                         | Moderate concerns                                                                                                                                                                                     |
|          |                       | 6. Comments                                                                                                                                                                 | No external validation was conducted<br>The study does not discuss the findings in the light of empirical studies assessing screening interventions or the findings from repatriation studies         |
|          |                       | 7. Has an internal validation process been described?                                                                                                                       | Not reported                                                                                                                                                                                          |
|          | Validation (internal) | 7. Comments                                                                                                                                                                 | No internal validation conducted                                                                                                                                                                      |
|          |                       | 8. Has the model been shown to be internally valid?                                                                                                                         | Moderate concerns                                                                                                                                                                                     |
|          |                       | 8. Comments                                                                                                                                                                 | No internal validation conducted                                                                                                                                                                      |
|          | Uncertainty           | 9. Was there an adequate assessment of the effects of uncertainty?                                                                                                          | Major concerns                                                                                                                                                                                        |
|          |                       | 9. Comments                                                                                                                                                                 | While the study itself does not provide a sensitivity analysis, it provides an App which should allow the reader to conduct sensitivity analyses; however the link provided for the app does not work |
|          | Transparency          | 10. Was technical documentation, in sufficient detail to allow (potentially) for replication, made available openly or under agreements that protect intellectual property? | No to minor concerns                                                                                                                                                                                  |
|          |                       | 10. Comments                                                                                                                                                                | Code to reproduce analysis is provided                                                                                                                                                                |
| Ryu 2020 | Model structure       | 1. Are the structural assumptions transparent and justified?                                                                                                                | No to minor concerns                                                                                                                                                                                  |
|          |                       | 1. Comments                                                                                                                                                                 | It is a relatively simple SEIR model<br>Study does not discuss why a more complex model was not used                                                                                                  |
|          |                       | 2. Are the structural assumptions reasonable given the overall objective, perspective and scope of the model?                                                               | Major concerns                                                                                                                                                                                        |
|          |                       | 2. Comments                                                                                                                                                                 | They assume all infected people will become symptomatic; however this is not relevant for the model (as it is focused on an assumption of share of participants being quarantined)                    |

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|                       |                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------------|--------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                       |                                                        | <p>The model assumes, that those who will be quarantined, will be quarantined straight away, without having the ability to infect someone</p> <p>The model does not allow for asymptomatic infectious</p> <p>Model assumes random contacts within the whole population of Seoul; the interaction of the students is likely much more compartmentalized</p> <p>Model assumes a perfect screening - no symptomatic infectious people arrive</p>                                                          |
| Input data            | 3. Are the input parameters transparent and justified? | Moderate concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                       | 3. Comments                                            | <p>Model is based on the assumption of 0.1%, 0.2%, or 1% of students being infected.</p> <p>This is justified by: "(i) were in the pre-infectious period of COVID-19 infection, based on previous literature reporting that 0.2% of individuals with contacts of SARS infection were asymptomatic"</p> <p>It is not clear, how the study authors came up with these parameters</p>                                                                                                                     |
|                       | 4. Are the input parameters reasonable?                | Major concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                       | 4. Comments                                            | <p>The assumption of 70%-100% of all infected people being quarantined and not breaking quarantine seems very high, given that around 30%-40% of all infections are asymptomatic</p> <p>The assumed incubation period seems a bit too long (6.5 days)</p> <p>The period from infectious to recovered is assumed to be 3.5 days. Within this model, the relevance of this parameters is the infectiousness period (only I is infectious). A period of 3.5 days infectiousness seems much too short.</p> |
| Validation (external) | 5. Has an external validation process been described?  | Not reported                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                       | 5. Comments                                            | <p>No external validation was conducted</p> <p>The study does not discuss the findings in the light of empirical studies assessing screening interventions or the findings from repatriation studies</p>                                                                                                                                                                                                                                                                                               |
|                       | 6. Has the model been shown to be externally valid?    | Moderate concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                       | 6. Comments                                            | <p>No external validation was conducted</p> <p>The study does not discuss the findings in the light of empirical studies assessing screening interventions or the findings from repatriation studies</p>                                                                                                                                                                                                                                                                                               |
| Validation (internal) | 7. Has an internal validation process been described?  | Not reported                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                       | 7. Comments                                            | No internal validation conducted                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

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|                 |                 |                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                       |
|-----------------|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                 |                 | 8. Has the model been shown to be internally valid?                                                                                                                         | Moderate concerns                                                                                                                                                                                                                                                                                     |
|                 |                 | 8. Comments                                                                                                                                                                 | No internal validation conducted                                                                                                                                                                                                                                                                      |
|                 | Uncertainty     | 9. Was there an adequate assessment of the effects of uncertainty?                                                                                                          | Moderate concerns                                                                                                                                                                                                                                                                                     |
|                 |                 | 9. Comments                                                                                                                                                                 | The study varies the compliance rate with quarantine (80%,80%,90%,100%) and the share of arriving infectious students (0.1%, 0.2%, 1%) but no further sensitivity analysis is conducted                                                                                                               |
|                 | Transparency    | 10. Was technical documentation, in sufficient detail to allow (potentially) for replication, made available openly or under agreements that protect intellectual property? | Moderate concerns                                                                                                                                                                                                                                                                                     |
|                 |                 | 10. Comments                                                                                                                                                                | Code not available; the SEIR model and the input parameters are well described and it should be possible to replicate the analysis                                                                                                                                                                    |
| Utsunomiya 2020 | Model structure | 1. Are the structural assumptions transparent and justified?                                                                                                                | No to minor concerns                                                                                                                                                                                                                                                                                  |
|                 |                 | 1. Comments                                                                                                                                                                 | Assume that the progression of COVID-19 for each country can be fitted to a sigmoidal function, at either the lagging, exponential, decelerating or stationary stage; they also added a fifth more flexible stage to allow for bi-directional changes due to public health interventions, for example |
|                 |                 | 2. Are the structural assumptions reasonable given the overall objective, perspective and scope of the model?                                                               | Moderate concerns                                                                                                                                                                                                                                                                                     |
|                 |                 | 2. Comments                                                                                                                                                                 | It is unclear whether a completely data-driven approach imposing a function onto the data is a reasonable approach; ignoring completely the transmission characteristics of COVID-19 as well as human behaviour and mobility may be problematic.                                                      |
|                 | Input data      | 3. Are the input parameters transparent and justified?                                                                                                                      | No to minor concerns                                                                                                                                                                                                                                                                                  |
|                 |                 | 3. Comments                                                                                                                                                                 | No real input parameters required for this data-driven approach, apart from the data on the daily cases of COVID-19                                                                                                                                                                                   |
|                 |                 | 4. Are the input parameters reasonable?                                                                                                                                     | No to minor concerns                                                                                                                                                                                                                                                                                  |
|                 |                 | 4. Comments                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                       |

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|------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
|            | Validation (external) | 5. Has an external validation process been described?                                                                                                                       | Reported                                                                                                             |
|            |                       | 5. Comments                                                                                                                                                                 | External validity assessed through predicting ECDC data 1 day in advance                                             |
|            |                       | 6. Has the model been shown to be externally valid?                                                                                                                         | No to minor concerns                                                                                                 |
|            |                       | 6. Comments                                                                                                                                                                 | Figure 3 shows that the model was able to accurately predict the ECDC data                                           |
|            | Validation (internal) | 7. Has an internal validation process been described?                                                                                                                       | Reported                                                                                                             |
|            |                       | 7. Comments                                                                                                                                                                 | Internal validation through the conduct of a simulation study; accuracy of estimates obtained by model was evaluated |
|            |                       | 8. Has the model been shown to be internally valid?                                                                                                                         | No to minor concerns                                                                                                 |
|            |                       | 8. Comments                                                                                                                                                                 | Figure 2 shows the results of the internal validity assessment                                                       |
|            | Uncertainty           | 9. Was there an adequate assessment of the effects of uncertainty?                                                                                                          | Major concerns                                                                                                       |
|            |                       | 9. Comments                                                                                                                                                                 | No real assessment of uncertainty through sensitivity analyses                                                       |
|            | Transparency          | 10. Was technical documentation, in sufficient detail to allow (potentially) for replication, made available openly or under agreements that protect intellectual property? | No to minor concerns                                                                                                 |
|            |                       | 10. Comments                                                                                                                                                                | Code and further information available at a linked Github repository                                                 |
| Wells 2020 | Model structure       | 1. Are the structural assumptions transparent and justified?                                                                                                                | No to minor concerns                                                                                                 |
|            |                       | 1. Comments                                                                                                                                                                 |                                                                                                                      |
|            |                       | 2. Are the structural assumptions reasonable given the overall objective, perspective and scope of the model?                                                               | No to minor concerns                                                                                                 |
|            |                       | 2. Comments                                                                                                                                                                 | Assumed that no infected individuals travelled from Wuhan after the travel lockdown enforced on 23 January 2020      |
|            | Input data            | 3. Are the input parameters transparent and justified?                                                                                                                      | No to minor concerns                                                                                                 |

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|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3. Comments           |                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                             |
| Validation (external) | 4. Are the input parameters reasonable?                                                                                                                                     | Moderate concerns                                                                                                                                                                                                                                                                                                           |
|                       | 4. Comments                                                                                                                                                                 | Assumes that all symptomatic cases are identified in screening<br>Assumes a very high effectiveness for self-reporting of exposure risk<br>Based on early data on transmission parameters; assumes that the maximum incubation period is 21 days; that all reported infected cases acquired infection within mainland China |
|                       | 5. Has an external validation process been described?                                                                                                                       | Reported                                                                                                                                                                                                                                                                                                                    |
|                       | 5. Comments                                                                                                                                                                 | Predicted arrival times compared against observed                                                                                                                                                                                                                                                                           |
|                       | 6. Has the model been shown to be externally valid?                                                                                                                         | No to minor concerns                                                                                                                                                                                                                                                                                                        |
|                       | 6. Comments                                                                                                                                                                 | Predicted first arrival times are generally consistent with reported international importation arrival dates                                                                                                                                                                                                                |
|                       | 7. Has an internal validation process been described?                                                                                                                       | Not reported                                                                                                                                                                                                                                                                                                                |
|                       | 7. Comments                                                                                                                                                                 | No internal validation                                                                                                                                                                                                                                                                                                      |
|                       | 8. Has the model been shown to be internally valid?                                                                                                                         | Moderate concerns                                                                                                                                                                                                                                                                                                           |
|                       | 8. Comments                                                                                                                                                                 | No internal validation                                                                                                                                                                                                                                                                                                      |
| Uncertainty           | 9. Was there an adequate assessment of the effects of uncertainty?                                                                                                          | No to minor concerns                                                                                                                                                                                                                                                                                                        |
|                       | 9. Comments                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                             |
| Transparency          | 10. Was technical documentation, in sufficient detail to allow (potentially) for replication, made available openly or under agreements that protect intellectual property? | No to minor concerns                                                                                                                                                                                                                                                                                                        |
|                       | 10. Comments                                                                                                                                                                | Code available on GitHub and extensive supplementary material available                                                                                                                                                                                                                                                     |
| Wilson 2020           | Model structure                                                                                                                                                             | 1. Are the structural assumptions transparent and justified?                                                                                                                                                                                                                                                                |
|                       | 1. Comments                                                                                                                                                                 | SEIR-based model; with different assumptions and modelled interventions (e.g. wearing masks based on flight) for the parameter of influx of in-                                                                                                                                                                             |

(Continued)

|                       |                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                               |
|-----------------------|---------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                       |                                                                                                               | ected cases to protected, disease-free region (New Zealand)                                                                                                                                                                                                                                                                                                                   |
|                       | 2. Are the structural assumptions reasonable given the overall objective, perspective and scope of the model? | Major concerns                                                                                                                                                                                                                                                                                                                                                                |
|                       | 2. Comments                                                                                                   | Model describes time until outbreak assuming that there is only one route of influx<br>The model does not assume any relevant counter-measures following a detected infection on a flight, which is unlikely.<br>They assume that the only entry point to New Zealand would be Australia. And if so, it is unlikely that the base risk is equal to the base risk of Australia |
| Input data            | 3. Are the input parameters transparent and justified?                                                        | No to minor concerns                                                                                                                                                                                                                                                                                                                                                          |
|                       | 3. Comments                                                                                                   | The study provides references for most assumptions                                                                                                                                                                                                                                                                                                                            |
|                       | 4. Are the input parameters reasonable?                                                                       | Major concerns                                                                                                                                                                                                                                                                                                                                                                |
|                       | 4. Comments                                                                                                   | While most assumptions on the variables are reported; there are a number of uncertainties in the underlying data. In particular, the assumptions for the effectiveness of the measures seem relatively arbitrary; e.g. on the effectiveness of entry/exit screening                                                                                                           |
| Validation (external) | 5. Has an external validation process been described?                                                         | Not reported                                                                                                                                                                                                                                                                                                                                                                  |
|                       | 5. Comments                                                                                                   | No external validation was conducted<br>The study does not discuss the findings in the light of empirical studies assessing screening interventions or the findings from repatriation studies                                                                                                                                                                                 |
|                       | 6. Has the model been shown to be externally valid?                                                           | Moderate concerns                                                                                                                                                                                                                                                                                                                                                             |
|                       | 6. Comments                                                                                                   | No external validation was conducted<br>The study does not discuss the findings in the light of empirical studies assessing screening interventions or the findings from repatriation studies                                                                                                                                                                                 |
| Validation (internal) | 7. Has an internal validation process been described?                                                         | Not reported                                                                                                                                                                                                                                                                                                                                                                  |
|                       | 7. Comments                                                                                                   | No internal validation conducted                                                                                                                                                                                                                                                                                                                                              |
|                       | 8. Has the model been shown to be internally valid?                                                           | Moderate concerns                                                                                                                                                                                                                                                                                                                                                             |

(Continued)

|              |                                                                                                                                                                             |                                                                                                                                    |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
|              | 8. Comments                                                                                                                                                                 | No internal validation conducted                                                                                                   |
| Uncertainty  | 9. Was there an adequate assessment of the effects of uncertainty?                                                                                                          | Major concerns                                                                                                                     |
|              | 9. Comments                                                                                                                                                                 | No to very limited sensitivity analyses                                                                                            |
| Transparency | 10. Was technical documentation, in sufficient detail to allow (potentially) for replication, made available openly or under agreements that protect intellectual property? | Moderate concerns                                                                                                                  |
|              | 10. Comments                                                                                                                                                                | Code not available; the SEIR model and the input parameters are well described and it should be possible to replicate the analysis |

**ECDC:** European Centre for Disease Prevention and Control; **PCR:** polymerase chain reaction; **SARS:** severe acute respiratory syndrome; **SARS-CoV-2:** severe acute respiratory syndrome coronavirus 2; **SEIR:** susceptible, exposed, infectious, recovered; **SIR:** susceptible, infected, recovered

## WHAT'S NEW

| Date              | Event   | Description          |
|-------------------|---------|----------------------|
| 17 September 2020 | Amended | Minor typo corrected |

## HISTORY

Review first published: Issue 9, 2020

## CONTRIBUTIONS OF AUTHORS

JB, AM and EAR developed the protocol, and JB and AM coordinated the overall review process. JS had substantial intellectual contribution in the conduct of this review, including data extraction, risk of bias assessment and evidence synthesis. JB, AM, and EAR put together the report. All other review authors are listed in alphabetical order, with everyone making substantial intellectual contribution.

Protocol development: JB, AM and EAR

Citation searches: SV

Title and abstract screening: MC, KG, KS, SV

Full-text screening: JB, MC, KG, AM, KS, SV

Data extraction: JB, KMFE-F, LMP, JMS, PvP

Risk of bias/quality assessment: JB, KMFE-F, JMS, SH, ML

GRADE assessment: JB, AM, EAR

Evidence synthesis: JB, JMS, PvP

Manuscript preparation: JB, AM, JMS, MC, KMFE-F, KG, SH, OH, ML, LMP, PvP, KS, SV, EAR

## DECLARATIONS OF INTEREST

**Jacob Burns:** the Chair for Public Health and Health Services Research at the Institute for Medical Information Processing, Biometry and Epidemiology received funding from the WHO for the conduct of this review. The WHO provided input which informed the review protocol and scope. The WHO did not exert any influence on how findings were interpreted. The role of WHO is clearly specified in the review itself. No other conflicts of interest are known to the review authors.

**Ani Movsisyan:** the Chair for Public Health and Health Services Research at the Institute for Medical Information Processing, Biometry and Epidemiology received funding from the WHO for the conduct of this review. The WHO provided input which informed the review protocol and scope. The WHO did not exert any influence on how findings were interpreted. The role of WHO is clearly specified in the review itself. No other conflicts of interest are known to the review authors.

**Jan M Stratil:** the Chair for Public Health and Health Services Research at the Institute for Medical Information Processing, Biometry and Epidemiology received funding from the WHO for the conduct of this review. The WHO provided input which informed the review protocol and scope. The WHO did not exert any influence on how findings were interpreted. The role of WHO is clearly specified in the review itself. No other conflicts of interest are known to the review authors.

**Michaela Coenen:** the Chair for Public Health and Health Services Research at the Institute for Medical Information Processing, Biometry and Epidemiology received funding from the WHO for the conduct of this review. The WHO provided input which informed the review protocol and scope. The WHO did not exert any influence on how findings were interpreted. The role of WHO is clearly specified in the review itself. No other conflicts of interest are known to the review authors.

**Karl Emmert-Fees:** none known

**Karin Geffert:** none known

**Sabine Hoffman:** none known

**Olaf Horstick:** none known

**Michael Laxy:** none known

**Lisa M Pfadenhauer:** the Chair for Public Health and Health Services Research at the Institute for Medical Information Processing, Biometry and Epidemiology received funding from the WHO for the conduct of this review. The WHO provided input which informed the review protocol and scope. The WHO did not exert any influence on how findings were interpreted. The role of WHO is clearly specified in the review itself. No other conflicts of interest are known to the review authors.

**Peter von Philipsborn:** the Chair for Public Health and Health Services Research at the Institute for Medical Information Processing, Biometry and Epidemiology received funding from the WHO for the conduct of this review. The WHO provided input which informed the review protocol and scope. The WHO did not exert any influence on how findings were interpreted. The role of WHO is clearly specified in the review itself. No other conflicts of interest are known to the review authors.

**Kerstin Sell:** the Chair for Public Health and Health Services Research at the Institute for Medical Information Processing, Biometry and Epidemiology received funding from the WHO for the conduct of this review. The WHO provided input which informed the review protocol and scope. The WHO did not exert any influence on how findings were interpreted. The role of WHO is clearly specified in the review itself. No other conflicts of interest are known to the review authors.

**Stephan Voss:** the Chair for Public Health and Health Services Research at the Institute for Medical Information Processing, Biometry and Epidemiology received funding from the WHO for the conduct of this review. The WHO provided input which informed the review protocol and scope. The WHO did not exert any influence on how findings were interpreted. The role of WHO is clearly specified in the review itself. No other conflicts of interest are known to the review authors.

**Eva Rehfuess:** the Chair for Public Health and Health Services Research at the Institute for Medical Information Processing, Biometry and Epidemiology received funding from the WHO for the conduct of this review. The WHO provided input which informed the review protocol and scope. The WHO did not exert any influence on how findings were interpreted. The role of WHO is clearly specified in the review itself. No other conflicts of interest are known to the review authors.

## SOURCES OF SUPPORT

### Internal sources

- No sources of support supplied

## External sources

- World Health Organization (WHO), Other

This review was requested and funded by WHO, who provided input which informed the review protocol and scope. The WHO did not exert any influence on how findings were interpreted.

## DIFFERENCES BETWEEN PROTOCOL AND REVIEW

There are some differences between the protocol ([Appendix 1](#)) and some sections of the review.

**Data extraction and management:** in the review protocol we specified that we would search for data from external sources, such as daily COVID-19 situation reports published by the WHO, to enhance our understanding of the specific features of travel-related control measures and the stage of pandemic at the time of implementing the measure. However, because of the lack of consistency of the information in these sources (e.g. discrepancies in how WHO reports describe the stage of pandemic in earlier months of 2020), we did not search these sources in the review.

**Assessment of risk of bias in included studies:** in the review protocol we specified using multiple 'Risk of bias' tools to assess the broad range of study types in the review, namely RoB2 tool for experimental studies, Risk of Bias in Non-randomised Studies – of Interventions (ROBINS-I) for quasi-experimental and observational studies and a bespoke tool we developed for assessing the quality of modelling studies. However, given that we identified additional sets of papers evaluating entry/exit screening that were more related to diagnostic studies than intervention evaluation, we decided post-protocol to apply an additional 'Risk of bias' tool, namely the Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) to assess risk of bias of these studies. Furthermore, based on the rounds of feedback from the modelling experts in our team, we slightly adapted the criteria in the bespoke tool we developed for assessing the quality of modelling studies. These included criteria related to input data, internal and external validity. However, this did not change the overall structure of the tool.

**Data synthesis:** in our review, we identified several studies evaluating entry and exit screening measures, which met the review eligibility criteria, but that did not provide sufficient information to fully inform data synthesis on relevant outcomes, such as the number of cases missed by the screening measure. We classified these studies as 'supporting studies' and summarised their results descriptively in the review. This process, however, was not prespecified in our protocol.

**Subgroup analyses and investigation of heterogeneity:** we specified in our protocol that we would investigate the influence of several sources of heterogeneity on the impact of interventions, including the stage of the pandemic during which the intervention was implemented, whether the country is an island state or not, assumed infectious disease parameters, and whether a single or a package of control measures were implemented. While we reflect on the potential impact of some of these sources in our review, we did not explore heterogeneity as planned, because of lack of data on these sources.

**Sensitivity analyses:** in our review protocol we specified that we would conduct a sensitivity analysis to assess the impact of studies at high risk of bias on the review findings. However, we did not conduct sensitivity analysis in the review given the nature of our narrative synthesis and as most of the evidence base was comprised of modelling studies with major quality concerns.

## INDEX TERMS

### Medical Subject Headings (MeSH)

Communicable Diseases, Imported [epidemiology] [prevention & control]; Coronavirus Infections [epidemiology] [prevention & control]; COVID-19 [epidemiology] [\*prevention & control]; Models, Theoretical; Observational Studies as Topic; Pandemics [\*prevention & control]; Quarantine; \*SARS-CoV-2; Severe Acute Respiratory Syndrome [epidemiology] [prevention & control]; \*Travel-Related Illness

### MeSH check words

Humans