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Supplementary appendix 1

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Appendix for

Temporal changes in mortality risk associated with particulate matter (PM_{10}) across 143 cities in 26 countries: a multicountry, multicity time-series study

Yongsoo Choi[1], Garam Byun[1], Honghyok Kim[2,3], Rory Stewart[1], Yimeng Song[4], Seulkee Heo[1], Jong-Tae Lee[5,6], Shilu Tong[7,8], Eric Lavigne[9,10], Nicolas Valdes-Ortega[11], Patricia Matus Correa[12], Samuel Osorio[13], Souzana Achilleos[14], Jan Kyselý[15,16], Aleš Urban[15,16], Dominic Roye[17,18], Hans Orru[19], Marek Maasikmets[20], Jouni J. K. Jaakkola[21,22], Niilo Ryti[21,22], Mathilde Pascal[23], Alexandra Schneider[24], Susanne Breitner[24,25], Klea Katsouyanni[26,27], Evangelia Samoli[26], Hanne Krage Carlsen[28], Alireza Enteyari[29], Fatemeh Mayvaneh[30], Raanan Raz[31], Massimo Stafoggia[32], Francesca de'Donato[32], Masahiro Hashizume[33], Chris Fook Sheng Ng[33], Lina Madaniyazi[34], Magali Hurtado Diaz[35], Eunice Elizabeth Félix Arellano[35], Jochem Klompmaker[36,37], Shilpa Rao[38], Joana Madureira[39,40,41], Vânia Gaio[42,43,44], Yuming Guo[45,46], Noah Scovronick[47], Rebecca M. Garland[48], Ho Kim[49], Whanhee Lee[50], Bertil Forsberg[51], Ana Maria Vicedo-Cabrera[52,53,54], Martina S. Ragettli[55,56], Yue Leon Guo[57,58,59], Shih-Chun Pan[58], Ben Armstrong[54], Francesco Sera[60], Antonio Gasparrini[61], Pierre Masselot[61], Malcolm Mistry[61,62], Antonella Zanobetti[63], Joel Schwartz[63], Michelle Bell[1]

[1]School of the Environment, Yale University, New Haven, CT 06511, USA
[2]Division of Environmental and Occupational Health Sciences, School of Public Health, University of Illinois Chicago, Chicago, IL 60612, USA
[3]Institute for Environmental Science and Policy, University of Illinois Chicago, Chicago, IL 60612, USA
[4]Department of Urban Planning and Design, Faculty of Architecture, The University of Hong Kong, Hong Kong SAR, China
[5]Interdisciplinary Program in Precision Public Health, Department of Public Health Sciences, Graduate School of Korea University, Seoul 02841, South Korea
[6]School of Health Policy and Management, College of Health Sciences, Korea University, Seoul 02841, South Korea
[7]National Institute of Environmental Health, Chinese Center for Disease Control and Prevention, Beijing 100021, China
[8]School of Public Health and Social Work, Queensland University of Technology, Brisbane 4059, Australia
[9]School of Epidemiology & Public Health, Faculty of Medicine, University of Ottawa, Ottawa K1H 8M5, Canada
[10]Environmental Health Science and Research Bureau, Health Canada, Ottawa K1A 0K9, Canada
[11]Centro Latinoamericano de Excelencia en Cambio Climático y Salud, Universidad Peruana Cayetano Heredia, Lima, Peru
[12]Department of Public Health, Universidad de los Andes, Santiago 7620001, Chile
[13]Department of Environmental Health, University of São Paulo, São Paulo 01246-904, Brazil
[14]Department of Primary Care and Population Health, University of Nicosia Medical School, Nicosia 2408, Cyprus
[15]Institute of Atmospheric Physics, Czech Academy of Sciences, Prague 14100, Czech Republic
[16]Faculty of Environmental Sciences, Czech University of Life Sciences, Prague 16500, Czech Republic
[17]Climate Research Foundation (FIC), Madrid 28028, Spain
[18]CIBERESP, Madrid 28029, Spain
[19]Department of Family Medicine and Public Health, University of Tartu, Tartu 50411, Estonia
[20]Estonian Environmental Research Centre, Tallinn 10617, Estonia
[21]Center for Environmental and Respiratory Health Research (CERH), University of Oulu, Oulu 90220, Finland
[22]Medical Research Center Oulu (MRC Oulu), Oulu University Hospital and University of Oulu, Oulu 90220, Finland
[23]Santé Publique France, Department of Environmental and Occupational Health, French National Public Health Agency, Saint Maurice 94410, France
[24]Institute of Epidemiology, Helmholtz Zentrum München, German Research Center for Environmental Health (GmbH), Neuherberg 85764, Germany
[25]Chair of Epidemiology, Institute for Medical Information Processing, Biometry, and Epidemiology (IBE), Faculty of Medicine, LMU Munich, Munich 80336, Germany
[26]Department of Hygiene, Epidemiology and Medical Statistics, National and Kapodistrian University of Athens, Athens 11527, Greece
[27]Environmental Research Group, School of Public Health, Imperial College, London W2 1PG, UK
[28]School of Public Health, University of Iceland, Reykjavik 102, Iceland
[29]Faculty of Geography and Environmental Sciences, Hakim Sabzevari University, Sabzevar 9617916487, Khorasan Razavi, Iran
[30]Institute of Epidemiology and Social Medicine, University of Münster, Münster 48149, Germany
[31]Braun School of Public Health and Community Medicine, The Hebrew University of Jerusalem, Jerusalem 9112102, Israel
[32]Department of Epidemiology, Lazio Regional Health Service, Rome 00147, Italy
[33]Department of Global Health Policy, Graduate School of Medicine, The University of Tokyo, Tokyo 113-0033, Japan
[34]School of Tropical Medicine and Global Health, Nagasaki University, Nagasaki 852-8523, Japan
[35]Department of Environmental Health, National Institute of Public Health, Cuernavaca, Morelos 62100, Mexico
[36]Centre for Sustainability, Environment and Health, National Institute for Public Health and the Environment, Bilthoven 3721 MA, the Netherlands
[37]Institute for Risk Assessment Sciences, Utrecht University, Utrecht 3584 CM, the Netherlands
[38]Norwegian Institute of Public Health, Oslo 0456, Norway
[39]Department of Environmental Health, Instituto Nacional de Saúde Dr. Ricardo Jorge, Porto 4000-055, Portugal
[40]EPIUnit - Instituto de Saúde Pública, Universidade do Porto, Porto 4050-600, Portugal
[41]Laboratório para a Investigação Integrativa e Translacional em Saúde Populacional (ITR), Porto 4050-313, Portugal
[42]Department of Epidemiology, Instituto Nacional de Saúde Dr. Ricardo Jorge, Lisbon 1649-016, Portugal
[43]Public Health Research Center, Escola Nacional de Saúde Pública, Universidade NOVA de Lisboa, Lisbon 1600-560, Portugal
[44]Comprehensive Health Research Center, Universidade NOVA de Lisboa, Lisbon 1099-085, Portugal
[45]Department of Epidemiology and Preventive Medicine, School of Public Health and Preventive Medicine, Monash University, Melbourne VIC 3004, Australia

[46]Climate, Air Quality Research Unit, School of Public Health and Preventive Medicine, Monash University, Melbourne, Australia
[47]Department of Environmental Health, Rollins School of Public Health, Emory University, Atlanta 30322, USA
[48]Department of Geography, Geoinformatics and Meteorology, University of Pretoria, Pretoria 0002, South Africa
[49]Graduate School of Public Health, Seoul National University, Seoul 08826, South Korea
[50]School of Biomedical Convergence Engineering, College of Information and Biomedical Engineering, Pusan National University, Yangsan 50612, South Korea
[51]Department of Public Health and Clinical Medicine, Umeå University, Umeå SE-901 87, Sweden
[52]Institute of Social and Preventive Medicine, University of Bern, Bern 3012, Switzerland
[53]Oeschger Centre for Climate Change Research, University of Bern, Bern 3012, Switzerland
[54]Department of Public Health, Environments and Society, London School of Hygiene & Tropical Medicine, London WC1E 7HT, UK
[55]Swiss Tropical and Public Health Institute, Allschwil 4123, Switzerland
[56]University of Basel, Basel 4001, Switzerland
[57]Environmental and Occupational Medicine, National Taiwan University (NTU) College of Medicine and NTU Hospital, Taipei 10051, Taiwan
[58]Research Center for Environmental Changes, Academia Sinica, Taipei, Taiwan
[59]Graduate Institute of Environmental and Occupational Health Sciences, NTU College of Public Health, Taipei 10055, Taiwan
[60]Department of Statistics, Computer Science and Applications "G. Parenti", University of Florence, Florence 50134, Italy
[61]Environment & Health Modelling (EHM) Lab, Department of Public Health, Environments and Society, London School of Hygiene & Tropical Medicine, London WC1E 7HT, UK
[62]Department of Economics, Ca' Foscari University of Venice, Venice 30121, Italy
[63]Department of Environmental Health, Harvard T.H. Chan School of Public Health, Boston, MA 02115, USA

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Supplementary methods:

Additional Information on Data Collection

This study gathered all-cause mortality, air pollution, and meteorological data from 143 cities across 26 countries. The dataset included a total of 23.4 million deaths. All data were obtained from the Multi-Country Multi-City (MCC) Collaborative Research Network database (homepage: https://mccstudy.lshtm.ac.uk). The MCC Network is an international collaboration of research teams conducting studies aimed at producing epidemiological evidence on the associations between environmental stressors, climate, and health outcomes. Air pollution and meteorological data were obtained from official national or governmental monitoring systems (networks of ground-based stations), and mortality data were obtained from official death registries. Each city has at least one measurement station in each city and if there were multiple measurement stations, we calculate daily average of them and matched with the daily number of mortality.

Cause-of-death coding followed ICD-9 through 1998 and ICD-10 from 1999 onward (ICD-9, 001-999 and E800-E999; ICD-10, A00-Z99), with country-specific adoption years. As of 2024, a total of 74 publications have been produced using the MCC dataset, of which 11 focus specifically on particulate matter and health.[1-11]

As of 2025, the MCC dataset includes data from more than 1,000 cities worldwide. For the present analysis, we selected cities that were most suitable for estimating temporal changes in the effects of PM_{10}, specifically those with long-term and stable monitoring records, because sufficiently long study periods were required to model temporal trends reliably. To ensure comparable data quality across cities, the following selection criteria were applied. Cities were included if daily data were available for mean PM_{10} concentrations, mean temperature, and all-cause mortality counts. We excluded cities where PM_{10} concentrations were not measured on a daily basis, those with fewer than 9 consecutive years of available data, and those with more than one consecutive year (≥365 days) of missing data. The following section reports details on country-specific data, such as data collection and instrumentation.

Canada (3 cities): Daily mortality data was obtained from Statistics Canada through access to the Canadian Mortality Database. Mean daily temperature (in °C), computed as the 24-hour average based on hourly measurements, was obtained from Environment Canada. A single weather station was selected for each city using the airport monitoring station located closest to the CMA center. Hourly measures of PM_{10}, $PM_{2.5}$, ozone (O_3), and NO_2 were collected from monitors located in urban areas of the National Air Pollution Surveillance (NAPS) network of Environment Canada, a government institution that operates ground monitoring stations across Canada. Daily PM_{10}, $PM_{2.5}$, and NO_2 levels were computed as the 24-h average and O_3 as the daily maximum 8-hour running average from hourly measurements in different stations and then averaged across stations within the same CMA with no missing data, with an average of 4 stations per city.

Chile (2 cities): Daily mortality counts have been provided by the Departamento de Estadisticas e Información de Salud of Chile. Data sets for air temperature came from SINCA (Sistema de Información Nacional de Calidad del Aire): http://sinca.mma.gob.cl/index.php/region/index/id/M. Data are calculated from hourly measurements in one monitoring station per city. Daily mean air pollutants concentrations (PM_{10}, $PM_{2.5}$ and NO_2) were also obtained from SINCA, and were based on hourly averages for every public monitory station (all of those stations are located in urban areas).

Colombia (1 city): Daily mortality data was obtained from Administrativo Nacional de Estadistica (DANE). Mean daily temperature (in °C), computed as the 24-hour average based on hourly measurements, was obtained from the Instituto de Hidrología, Meteorología y Estudios Ambientales de Colombia (IDEAM). A single weather station was selected for each city. Measurements for PM_{10}, NO_2, and O_3 were available from the Environmental Secretary of Bogotá. Monitoring stations measured hourly air pollutants for each station, and 24-h averages were calculated. For each city, the average among monitoring stations was calculated.

Cyprus (5 cities): Daily mortality used in this study was collected by the Health Monitoring Unit of the Ministry of Health of Cyprus. The ideas and opinions expressed herein are those of the author. Endorsement of these ideas and opinions by the Ministry of Health of Cyprus is not intended nor should it be inferred. Deaths refer to citizens of each city. Daily mean air temperature data are provided by the Department of Meteorology, Ministry of Agriculture, Rural Development, and the Environment. Air pollution daily concentrations are provided by the Air Quality and Strategic Planning Section, Department of Labour Inspection, Ministry of Labour, Welfare and Social Insurance. These come from one traffic station in each city, PM concentrations are gravimetric, and all concentrations are expressed in $\mu g/m^3$.

Czech Republic (1 city): Daily mortality data was obtained from the Czech Statistical Office and the Institute of Health Information and Statistics. Mean daily temperature (in °C), computed as the average of observations in standard climatic terms (7:00, 14:00, and 21:00 local time), was collected by the Czech Hydrometeorological Institute. The average value was calculated according to the formula (T07 + T14 + 2*T21)/4. Information about daily PM_{10} and NO_2 levels, computed as 24-hour averages and the maximum 8-hour running average for O_3, were provided by the Czech Hydrometeorological Institute. The daily values were calculated from 4 stations (2 urban + 2 suburban).

Ecuador (1 city): Daily mortality was provided by the Instituto Nacional de Estadística y Censos as all-cause. Meterological data were obtained from WMONOAA (Surface Data Hourly Global, DS3505). Twenty four-hour averages are used as daily values for $PM_{2.5}$, and NO_2.

Estonia (4 ciries): Daily mortality data was obtained from the Estonian Causes of Death Registry. Mean daily temperature (in °C) was computed as the 24-h average of hourly measurements collected from the Estonian Environment Agency. A single weather station located nearby the urban area was selected for each city. Hourly measurements of PM_{10}, $PM_{2.5}$, NO_2, and O_3 were collected from urban background stations run by the Estonian Environmental Research Centre. Daily PM_{10}, $PM_{2.5}$ and NO_2 levels were computed as 24-hour averages and O_3 as the daily maximum 8-hour running average from hourly measurements; for each pollutant, the city average among monitoring stations was calculated.

Finland (1 city): The daily number of deaths was obtained from Statistics Finland. A dataset containing weather variables was obtained from Helsinki Region Environmental Services Authority. Measures of PM_{10}, $PM_{2.5}$, O_3, and NO_2 were extracted, from a nationwide dataset compiled by the Finnish Meteorological Institute, for a single coordinate at Helsinki city center using Geographic Information System (GIS).

France (20 cities): Daily mortality data was obtained from the French National Institute of Health and Medical Research (CepiDC). Mean daily temperature (in °C), computed as the mean of the minimum and maximum temperature, and relative humidity (%) was obtained from Meteo France. Hourly measurements of PM_{10} and O_3 were collected through the French local air quality monitoring network (Associations Agréées de Surveillance de la Qualité de l'Air AASQA). For PM_{10}, we used only urban stations, and for O_3, urban and peri-urban stations. Daily PM_{10} levels were computed as 24-h averages and O_3 as the daily maximum 8 hour running average from hourly measurements. Measurements were obtained from multiple stations (with different numbers for each city).

Germany (13 cities): Daily mortality data was obtained from the Research Data Centers of the Federation and the Federal States of Germany (Forschungsdatenzentrum der Statistischen Ämter des Bundes und der Länder). Mean daily temperature (in °C), computed as the 24-h average based on hourly measurements, was obtained from the Climate Data Centre of the German National Meteorological Service (Deutscher Wetterdienst). Where several weather stations existed within the city boundaries, stations closest to the city center were chosen, provided that measurements were available for the whole study period. Hourly measurements of PM_{10}, $PM_{2.5}$, O_3, and NO_2 were collected through the German Environment Agency (Umweltbundesamt) from urban background stations. Daily PM_{10}, $PM_{2.5}$, and NO_2 levels were computed as the 24-h average and O_3 as the daily maximum 8-hour running average from hourly measurements. Measurements were obtained from multiple stations (with different numbers for each city).

Greece (1 city): Daily mortality data was collected by Hellenic Statistical Authority. Mean daily temperature (in °C) and relative humidity (%) were computed as the 24-h average based on hourly measurements collected from the National Observatory of Athens from site "Thisio", located in the city of Athens. Hourly measurements of PM_{10}, $PM_{2.5}$, NO_2, and O_3 were obtained from the Ministry of Environment and Energy fixed-site monitoring network. Urban or suburban fixed monitoring background or traffic sites were selected. Daily PM_{10}, $PM_{2.5}$, and NO_2 levels were computed as 24-hour averages and O_3 as the daily maximum 8-hour running average from hourly measurements.

Iceland (1 city): Daily mortality data for one city, Reykjavik, are provided by the Directorate of Health in Iceland, Causes of Death Register. They include deaths from non-external causes among all individuals aged 18+ years. Daily mean air temperature data have been provided by the Icelandic Meteorological Institute from one station located in proximity of the capital city. Daily mean concentrations of PM_{10} have been measured in one monitoring station and provided by the Icelandic EPA (umhverfisstofnun) and by City of Reykjavik municipality.

Iran (1 city): Daily mortality of all causes was provided by the Ferdows organization of Mashhad Municipality. Mean, maximum, and minimum daily temperature (in °C) and relative humidity (in %), computed as the 24 hour average based on hourly measurements collected from IRAN Meteorological Organization (IRIMO) (http://www.irimo.ir). Twenty four-hour averages are used as daily values for PM_{10} and NO_2.

Israel (4 cities): Daily mortality for Tel Aviv and Haifa are at district level, for Jerusalem and Beer Sheva are at the city level. Daily death counts sourced from the Israeli Central Bureau of Statistics. Mean daily temperature (in °C) was computed as the 24-h average based on hourly measurements in one station per city. Daily mean air pollution measurements of NO_2, PM_{10} and $PM_{2.5}$ are sourced from one population monitoring station in each district/city which has the longest and fullest records. Records start in 1/01/2000 and are reasonably complete.

Italy (13 cities): Daily mortality data was obtained from local mortality registries and the rapid mortality surveillance system. Mean daily temperature (in °C) was computed as the 24-h average based on 6-h measurements obtained from the Meteorological Service of the Italian Air Force. A single weather station was selected for each city, using the airport monitoring station located closest to the city center. Hourly measurements of PM_{10}, $PM_{2.5}$, O_3, and NO_2 were obtained from the same period. Daily PM_{10}, $PM_{2.5}$, and NO_2 levels were computed as 24-hour averages and O_3 as the daily maximum 8-hour running average from hourly measurements.

Japan (7 cities): Daily mortality data was obtained from computerized death certificate data from the Ministry of Health, Labour and Welfare, Japan. Mean daily temperature (in °C), computed as the 24-h average based on hourly measurements, was obtained from the Japan Meteorological Agency. A single weather station located within the urban area of the city was selected. Hourly measurements of PM_{10}, $PM_{2.5}$, O_3, and NO_2 were collected from the urban monitors within the capital cities maintained by the Ministry of the Environment of Japan. Daily PM_{10}, $PM_{2.5}$, and NO_2 levels were computed as 24-hour averages and O_3 as the daily maximum 8-hour running average from hourly measurements.

Mexico (4 cities): Daily mortality data was obtained from the National Institute of Statistics, Geography and Informatics. Mean daily temperature (in °C) were computed as the 24-hour average based on hourly measurements collected through the Servicio Meteorológico Nacional (SMN) and the Instituto Nacional de Ecología y Cambio Climático (INECC). Hourly measurements of PM_{10}, $PM_{2.5}$, and O_3 were obtained from urban monitors of the local monitoring network. Daily PM_{10}, $PM_{2.5}$, and NO_2 levels were computed as 24-hour averages and O_3 as the daily maximum 8-hour running average from hourly measurements.

Norway (1 city): Aggregated daily mortality data was obtained from the Cause of Death Registry of Norway. Daily mean air temperatures on a 1 km grid across Norway were obtained from the observationally gridded se-norge 2 datasets of the Norwegian Meteorological Institute (MET Norway). The dataset is continuously updated based on measurement data from stations. Daily values for Norway of PM_{10}, $PM_{2.5}$, O_3, and NO_2 at a 1 km resolution were sourced from the Nordic DEHM-UBM (Danish Eulerian Hemispheric ModelUrban Background Model) setup (insert reference). Daily PM_{10}, $PM_{2.5}$, and NO_2 levels were computed as 24-hour averages and O_3 as the daily maximum 8-hour running average from hourly measurements.

Portugal (4 cities): Daily mortality was obtained from Statistics Portugal. Mean daily temperature (in °C) was computed as the 24-h average based on hourly measurements collected from the National Oceanic and Atmospheric Administration (NOAA). Hourly measurements of pollutants were gathered from the "online database of air quality" through the Portuguese Environment Agency from urban monitors. Daily PM_{10}, $PM_{2.5}$, and NO_2 levels were computed as 24-hour averages and O_3 as the daily maximum 8-hour running average from hourly measurements. The year 2016 was removed from the analysis due to anomalies in the mortality data.

South Africa (1 city): Daily mortality data was obtained from Statistics South Africa. Mean daily temperature (in °C) was computed as the average between daily minimum and maximum temperature collected from the

Agricultural Research Council of South Africa and the National Oceanic and Atmospheric Administration (NOAA). Hourly measurements of PM_{10}, $PM_{2.5}$, NO_2, and O_3 were collected at sites managed by the Department of Environmental Affairs (DEA). Daily PM_{10} levels were computed as the 24-hour mean, and O_3 as the daily maximum 8-hour running average from the respective provided hourly measurements. The 4 average 24-hour mean or daily maximum 8-hour running average values per district municipality (DM) were then calculated from all sites within each DM. Except for the ESKOM run stations, all air quality data were accessed through SAAQIS (http://www.saaqis.org.za/), which is run and hosted by the South African Weather Service.

South Korea (7 cities): Daily mortality was obtained from the Korea National Statistics Office. Mean daily temperature (in °C) was computed as the 24-h average based on hourly measurements. Measures of PM_{10}, $PM_{2.5}$, O_3, and NO_2 were available from monitors of the National Institute of Environmental Research. Daily PM_{10}, $PM_{2.5}$, and NO_2 levels were computed as 24-hour averages and O_3 as the daily maximum 8-hour running average from hourly measurements.

Sweden (1 city): Daily mortality data was obtained from the Swedish Cause of Death Register at the Swedish National Board of Health and Welfare. Mean daily temperature (in °C), computed as the 24-hour average based on hourly measurements, was obtained from the Environment and Health Administration. A single weather station, located at Torkel Knutssongatan in Central Stockholm, was selected. Hourly measurements of PM_{10}, $PM_{2.5}$, and NO_2 were collected from the main urban background (roof-top level) monitor run by the local monitoring network. Daily PM_{10}, $PM_{2.5}$, and NO_2 levels were computed as 24-hour averages and O_3 as the daily maximum 8-hour running average from hourly measurements.

Switzerland (8 cities): Daily mortality data was provided by the Federal Office of Statistics (Switzerland). Mean daily temperature (in °C), computed as the 24-h average based on hourly measurements, was obtained from the IDAWEB database (a service provided by MeteoSwiss, the Swiss Federal Office of Meteorology and Climatology). A single weather station located within or near the urban area was selected for each city. Hourly measurements of PM_{10}, $PM_{2.5}$, O_3, and NO_2 were provided by the Immissionsdatenbank Luft (IDB, Federal Office of the Environment, Bern, Switzerland). Daily PM_{10}, $PM_{2.5}$, and NO_2 levels were computed as 24-hour averages and O_3 as the daily maximum 8-hour running average from hourly measurements from urban monitoring stations.

Taiwan (3 cities): Daily mortality data was obtained from the Department of Health in Taiwan. Mean daily temperature (in °C) was computed as the 24-h average based on hourly measurements. Hourly measurements of PM_{10}, $PM_{2.5}$, O_3, and NO_2 were obtained from urban monitors of the local monitoring network. Daily PM_{10}, $PM_{2.5}$, and NO_2 levels were computed as 24-hour averages and O_3 as the daily maximum 8-hour running average from hourly measurements. Measurements were obtained from multiple stations (with different numbers for each city).

United Kingdom (23 cities): Daily mortality data was gathered from the Office for National Statistics. Mean daily temperature (in °C) was obtained from the British Atmospheric Data Centre. Daily PM_{10}, $PM_{2.5}$, O_3, and NO_2 levels were obtained from the Automatic Urban and Rural Network (AURN) repository, the Welsh Air Quality Network (WAQN) archive and the King's College London (KCL) dataset. The urban and sub-urban monitoring stations within the selected boundaries were considered. Those classified as “Roadside/Trac”, “Industrial”, “Portable/ Mobile”, and “Indoor” were excluded due to the unrepresentative nature of the average exposure.

United States (13 cities): Daily mortality data was obtained from the National Center for Health Statistics (NCHS). Mean daily temperature (in °C), computed as the 24-h average based on hourly measurements, was obtained from the National Climatic Data Center (NCDC) of the National Oceanic and Atmospheric Administration (NOAA). Hourly measurements of PM_{10}, $PM_{2.5}$, O_3, and NO_2 were gathered from the US Environmental Protection Agency (EPA) Air Quality System (AQS), from urban and sub-urban monitoring stations. Daily PM_{10}, $PM_{2.5}$, and NO_2 levels were computed as 24-hour averages and O_3 as the daily maximum 8-hour running average, from urban monitoring stations from monitors located in the county or set of contiguous counties in which the city is located.

Additional information on statistical analysis

To characterize temporal variation in the PM_{10}–mortality association, we used a two-stage longitudinal design. In stage 1, for each city we split the time series into non-overlapping three-year windows and fitted quasi-Poisson log-linear models to daily all-cause deaths. The outcome Y_{ict} denotes the death count for city i, window c, and day t. Each model included the two-day moving average of PM_{10}; a natural cubic spline of calendar time with 7 degrees of freedom per year to adjust for long-term/seasonal trends; day-of-week indicators (DOW); and a natural spline of the 0–3-day temperature (6 degrees of freedom), with lagged effects represented by the moving average. Overdispersion was accommodated via the quasi-Poisson variance.

$$Y_{ict} \mid \mu_{ict} \sim quasi\_Poisson\ (\mu_{ict}, \phi_{ic})$$

$$\log(\mu_{ict}) \sim \alpha_{ic} + \beta_{ic} PM_{ict} + s_{time}(t;\ df = 7 \times 3) + DOW_t + s_{temp}(temp_{ict,0-3}, df = 6)$$

In the second stage, we modeled temporal change in the PM_{10}–mortality association using a longitudinal mixed-effects meta-regression. Stage 1 city-window estimates $\widehat{\beta_{ic}}$ with standard errors s_{ic} were regressed on calendar year t_{ic} (the midpoint of each 3-year window), treating s_{ic}^2 as within-study variances (inverse-variance weighting). In identifying the temporal trend, we included a linear fixed effect term of calendar year, t_{ic} to capture the temporal trend, and random intercepts for country ($u_{k[i]}$) and city (v_i) to account for between-region heterogeneity. To explore potential factors associated with the trend, we augmented the model with time- and city-specific covariates (per capita GDP, the percentage of the population aged 65 years or older, annual mean PM10, temperature, and EVI) entered individually as fixed effects (cov_{ic}). Parameters were estimated by restricted maximum likelihood, with best linear unbiased predictions (BLUPs) used for the random effects.

$$\widehat{\beta_{ic}} \mid \theta_{ic} \sim N(\theta_{ic}, s_{ic}^2)$$

$$\theta_{ic} = \beta_0 + \beta_1 t_{ic} + \beta_2 cov_{ic} + u_{k[i]} + v_i$$

$$u_k \sim N\left(0, \tau_{country}^2\right), v_i \sim N(0, \tau_{city}^2)$$

Supplementary results:

eTable 1. Daily mean and standard deviation of all-cause mortality, PM_{10}, and temperature in 143 cities across 26 countries, broken down by city level.

Country	City	Period	All-cause mortality	PM10(μg/m³)	Temperature (°C)
Canada	Regina	2001-2011	5·4 (2·3)	23·6 (17·0)	2·8 (13·4)
Canada	Victoria	2001-2011	9·3 (3·2)	14·0 (8·3)	10·2 (5·2)
Canada	Winnipeg	2000-2011	18·5 (4·5)	15·8 (12·2)	3·2 (14·1)
Chile	Temuco	2004-2012	4·9 (2·2)	58·2 (53·7)	11·4 (4·0)
Chile	Valparaiso	2004-2013	14·0 (4·8)	42·7 (17·4)	14·7 (3·0)
Colombia	Bogota	2002-2013	74·6 (10·4)	62·7 (19·3)	13·9 (0·9)
Cyprus	Famagusta	2010-2019	0·7 (0·9)	38·8 (43·9)	20·5 (6·2)
Cyprus	Larnaka	2005-2019	2·3 (1·6)	47·4 (51·4)	20·5 (6·0)
Cyprus	Limassol	2005-2019	4·0 (2·1)	45·5 (37·5)	21·3 (5·8)
Cyprus	Nicosia	2005-2019	5·3 (2·5)	47·7 (35·8)	20·5 (7·4)
Cyprus	Pafos	2005-2019	1·5 (1·3)	37·4 (36·8)	20·0 (5·1)
Czech Republic	Prague	1994-2009	36·6 (7·3)	36·2 (24·6)	8·8 (8·1)
Ecuador	Quito	2014-2019	30·7 (6·4)	46·8 (16·6)	15·6 (1·1)
Estonia	Kohtla-Jarve Linn	2003-2019	2·2 (1·6)	14·7 (11·2)	5·7 (9·1)
Estonia	Narva Linn	2009-2019	2·3 (1·5)	13·2 (8·0)	5·8 (9·2)
Estonia	Tallinn	2005-2019	12·8 (3·8)	20·3 (15·5)	6·7 (8·5)
Estonia	Tartu Linn	2009-2019	2·9 (1·7)	16·9 (10·9)	6·5 (9·3)
Finland	Helsinki	1994-2014	20·0 (4·7)	19·9 (16·4)	6·2 (8·9)
France	Bordeaux	2000-2017	13·5 (3·9)	21·1 (10·2)	14·0 (6·4)
France	Clermont-Ferrand	2000-2017	5·7 (2·6)	19·2 (10·8)	12·2 (7·1)
France	Dijon	2000-2017	4·9 (2·3)	18·9 (10·3)	11·4 (7·3)
France	Grenoble	2000-2017	8·5 (3·1)	23·6 (12·7)	11·7 (7·4)
France	Le Havre	2000-2017	6·1 (2·6)	21·5 (12·0)	11·7 (5·3)
France	Lens-Douai	2000-2017	9·2 (3·2)	22·9 (12·9)	11·2 (6·2)
France	Lille	2000-2017	22·6 (5·2)	24·7 (13·4)	11·2 (6·2)
France	Lyon	2000-2017	19·3 (5·0)	24·7 (14·1)	13·1 (7·6)
France	Marseille	2000-2017	23·6 (5·6)	29·3 (11·7)	15·8 (7·0)
France	Montpellier	2000-2017	7·0 (2·8)	21·2 (10·7)	15·5 (6·6)
France	Nancy	2000-2017	7·4 (2·9)	22·8 (12·8)	11·1 (7·2)
France	Nantes	2000-2017	11·3 (3·6)	18·5 (9·2)	12·7 (5·8)
France	Nice	2002-2017	12·8 (3·9)	26·7 (8·7)	16·4 (5·9)
France	Orleans	2000-2017	4·9 (2·3)	18·1 (11·2)	11·6 (6·5)
France	Paris	2000-2017	112·6 (21·5)	23·5 (12·0)	12·7 (6·5)
France	Rennes	2000-2015	4·2 (2·1)	19·0 (10·5)	12·3 (5·7)
France	Rouen	2000-2017	10·6 (3·4)	22·4 (11·9)	10·9 (6·0)
France	Strasbourg	2000-2017	8·9 (3·1)	22·8 (12·7)	11·4 (7·5)
France	Toulouse	2000-2017	12·8 (3·8)	20·4 (9·6)	14·1 (6·9)
France	Tours	2000-2017	5·3 (2·6)	19·1 (9·8)	12·3 (6·4)
Germany	Berlin	2002-2019	93·1 (13·4)	24·8 (15·0)	10·6 (7·9)
Germany	Bremen	2003-2019	18·9 (4·8)	19·0 (10·2)	10·1 (6·9)
Germany	Dortmund	2003-2019	18·8 (4·8)	23·6 (14·0)	10·6 (6·8)
Germany	Dresden	2003-2019	15·7 (4·3)	23·5 (15·6)	10·0 (8·0)
Germany	Dusseldorf	2004-2015	18·4 (4·5)	22·6 (11·8)	11·0 (6·7)
Germany	Essen	2003-2019	22·7 (5·2)	25·6 (14·1)	10·7 (6·9)
Germany	Frankfurt	2000-2019	19·9 (4·9)	23·5 (13·3)	11·2 (7·5)
Germany	Hamburg	2001-2019	51·9 (8·7)	24·3 (14·0)	9·9 (6·9)
Germany	Hannover	2001-2015	33·1 (6·4)	22·2 (14·4)	10·1 (7·1)
Germany	Koeln	2003-2019	27·6 (6·0)	20·6 (12·0)	10·9 (6·9)
Germany	Leipzig	2003-2019	19·4 (4·9)	20·1 (13·3)	10·2 (7·7)
Germany	Munich	2000-2019	35·4 (6·6)	22·9 (16·2)	10·3 (7·9)
Germany	Stuttgart	2000-2019	16·3 (4·4)	21·0 (13·2)	11·0 (7·6)
Greece	Athens	2001-2010	78·9 (12·4)	43·9 (23·5)	18·7 (7·5)
Iceland	Reykjavik	2002-2018	3·7 (2·0)	21·0 (18·9)	5·5 (5·0)
Iran	Tehran	2002-2012	134·1 (15·0)	88·4 (47·2)	17·3 (9·9)

Israel	Beer Sheva	2001-2019	3·7 (2·0)	54·8 (88·6)	21·3 (6·2)
Israel	Haifa	2000-2019	12·7 (3·9)	42·4 (54·2)	21·6 (5·8)
Israel	Jerusalem	2002-2019	9·2 (3·3)	57·0 (100·3)	18·6 (6·5)
Israel	Tel Aviv	2000-2019	26·5 (6·1)	51·9 (62·3)	20·9 (5·6)
Italy	Ancona	2006-2014	2·6 (1·6)	37·8 (16·9)	14·8 (7·1)
Italy	Bari	2006-2015	6·2 (2·8)	27·1 (12·2)	16·5 (6·9)
Italy	Bologna	2006-2015	12·0 (3·8)	29·6 (17·0)	14·4 (8·5)
Italy	Cagliari	2006-2015	3·5 (2·0)	32·4 (13·4)	17·4 (6·0)
Italy	Florence	2006-2015	10·7 (3·6)	30·1 (14·5)	15·7 (7·3)
Italy	Frosinone	2006-2015	1·0 (1·0)	48·6 (40·3)	15·6 (7·5)
Italy	Genoa	2006-2015	20·8 (5·3)	25·8 (9·8)	16·5 (6·2)
Italy	Latina	2006-2015	2·4 (1·6)	29·5 (14·2)	17·3 (6·9)
Italy	Milan	2006-2015	30·2 (6·6)	43·6 (28·9)	14·2 (8·3)
Italy	Rome	2006-2015	62·1 (10·6)	31·5 (13·9)	16·0 (7·0)
Italy	Trieste	2006-2015	7·1 (2·9)	25·5 (15·4)	15·6 (7·3)
Italy	Turin	2006-2015	21·7 (5·7)	45·9 (32·2)	12·9 (7·9)
Italy	Viterbo	2006-2015	1·6 (1·3)	23·4 (10·4)	15·1 (7·4)
Japan	Fukuoka	1984-2008	19·9 (5·9)	34·6 (16·9)	17·0 (7·8)
Japan	Kitakyushu	1983-2008	22·1 (5·9)	34·3 (18·9)	17·0 (7·8)
Japan	Nagoya	1979-2008	37·9 (9·6)	45·6 (25·5)	15·8 (8·4)
Japan	Osaka	1980-2008	57·4 (13·6)	43·9 (25·3)	16·9 (8·3)
Japan	Sapporo	1992-2019	36·7 (11·8)	16·1 (9·6)	9·2 (9·5)
Japan	Sendai	1986-2019	16·5 (6·5)	25·2 (14·3)	12·7 (8·3)
Japan	Tokyo	1979-2019	162·9 (37·7)	44·0 (29·2)	16·3 (7·8)
Mexico	Guadalajara	2000-2009	54·1 (9·8)	49·0 (20·0)	21·2 (2·7)
Mexico	Puebla-Tlaxcala	2001-2009	32·2 (6·9)	42·4 (21·1)	16·7 (2·4)
Mexico	Toluca de Lerdo	2000-2008	19·6 (5·1)	65·7 (36·2)	14·1 (2·2)
Mexico	Valley of Mexico	2000-2012	244·7 (38·7)	51·7 (20·5)	16·3 (2·5)
Norway	Oslo	2000-2018	12·4 (3·9)	21·5 (12·4)	5·7 (8·2)
Portugal	Castelobranco	2004-2018	7·9 (3·1)	14·1 (11·7)	16·0 (7·0)
Portugal	Coimbra	2003-2018	13·8 (4·4)	21·4 (13·7)	15·2 (5·0)
Portugal	Lisboa	2000-2018	58·0 (12·0)	25·6 (15·0)	16·9 (5·0)
Portugal	Porto	1999-2018	40·0 (9·6)	30·8 (20·8)	15·0 (4·4)
South Africa	City of Johannesburg	2004-2013	94·4 (17·5)	56·8 (29·9)	16·7 (4·3)
South Korea	Busan	1999-2015	52·5 (8·4)	54·2 (30·7)	15·0 (8·1)
South Korea	Daegu	1999-2015	32·3 (6·4)	53·8 (31·7)	14·7 (9·5)
South Korea	Daejeon	1999-2015	16·7 (4·3)	46·4 (30·0)	13·2 (10·0)
South Korea	Gwangju	1999-2015	17·0 (4·5)	47·4 (29·9)	14·2 (9·4)
South Korea	Incheon	1999-2015	31·8 (6·6)	56·6 (33·2)	12·7 (9·9)
South Korea	Seoul	1999-2015	107·8 (13·2)	57·9 (41·1)	12·9 (10·4)
South Korea	Ulsan	1999-2015	11·6 (3·6)	49·2 (28·2)	14·5 (8·6)
Sweden	Stockholm	1994-2010	25·9 (5·6)	14·9 (8·7)	7·2 (8·2)
Switzerland	Basel	1995-2013	5·4 (2·4)	22·1 (14·9)	10·8 (7·4)
Switzerland	Bern	1995-2013	4·1 (2·1)	33·5 (18·1)	9·4 (7·6)
Switzerland	Geneve	1998-2013	3·7 (2·0)	23·5 (14·2)	11·1 (7·5)
Switzerland	Lausanne	1995-2013	3·0 (1·8)	27·5 (17·1)	11·3 (7·2)
Switzerland	Lugano	1995-2013	4·1 (2·1)	29·4 (20·0)	12·9 (7·1)
Switzerland	Luzern	2001-2013	2·1 (1·5)	22·0 (14·1)	10·0 (7·6)
Switzerland	St· Gallen	1995-2013	2·0 (1·4)	19·3 (13·8)	8·6 (7·6)
Switzerland	Zürich	1995-2013	10·6 (3·6)	23·7 (15·5)	9·7 (7·5)
Taiwan	Kaohsiung	1994-2014	43·3 (8·3)	79·3 (38·9)	25·3 (3·9)
Taiwan	Taichung	1994-2014	33·5 (7·3)	60·5 (29·7)	23·5 (4·9)
Taiwan	Taipei	1994-2014	81·0 (14·2)	50·8 (25·2)	23·1 (5·4)
UK	Birkenhead	2000-2008	7·2 (2·8)	19·2 (10·5)	10·8 (4·8)
UK	Bristol	1993-2016	11·4 (3·8)	24·0 (13·8)	11·0 (5·1)
UK	Cardiff	1994-2016	7·6 (3·0)	26·5 (13·8)	11·0 (5·1)
UK	Chesterfield	2008-2016	1·8 (1·3)	17·8 (10·6)	9·8 (5·3)
UK	Crawley	2001-2016	2·5 (1·6)	20·4 (9·6)	10·6 (5·4)
UK	Eastbourne	2001-2016	2·3 (1·5)	21·9 (10·6)	11·2 (5·0)
UK	Kingston upon Hull	1994-2014	6·9 (2·8)	23·9 (13·6)	10·6 (5·3)
UK	Leicester	1994-2013	8·7 (3·2)	21·5 (11·3)	10·1 (5·5)
UK	London	1992-2016	162·8 (31·9)	25·0 (13·4)	11·4 (5·5)

UK	Manchester	1996-2016	49·6 (10·4)	21·7 (11·7)	10·2 (5·1)
UK	Medway Towns	1997-2009	4·3 (2·2)	20·0 (11·0)	11·3 (5·5)
UK	Newport	2002-2016	4·0 (2·0)	18·3 (9·6)	10·6 (5·1)
UK	Nottingham	1997-2016	13·4 (4·2)	23·2 (11·7)	10·5 (5·3)
UK	Plymouth	1998-2016	4·9 (2·3)	19·0 (10·1)	11·1 (4·5)
UK	Preston	2000-2008	4·6 (2·2)	19·4 (10·1)	10·4 (4·9)
UK	Reading	1998-2016	4·2 (2·1)	18·8 (10·6)	11·0 (5·4)
UK	Sheffield	1996-2016	12·3 (4·1)	22·5 (13·6)	10·1 (5·2)
UK	Southampton	1994-2006	7·5 (2·9)	27·1 (11·4)	12·0 (5·1)
UK	Southend-on-Sea	2000-2008	6·6 (2·8)	20·4 (10·2)	11·4 (5·4)
UK	Stoke-on-Trent	1998-2014	7·0 (2·9)	21·7 (11·1)	9·6 (5·1)
UK	Swansea	1995-2016	4·4 (2·2)	25·0 (13·0)	11·2 (4·7)
UK	Tyneside	1992-2016	17·6 (5·0)	20·4 (13·0)	9·7 (4·8)
UK	York	2008-2016	2·4 (1·6)	16·4 (9·5)	10·2 (5·4)
USA	Cleveland (OH)	1987-2000	38·5 (7·0)	39·7 (18·6)	10·5 (10·0)
USA	Chicago (IL)	1990-2006	138·3 (17·7)	30·5 (15·7)	11·3 (10·4)
USA	Davenport (IA)	1996-2006	6·8 (2·7)	29·0 (18·3)	10·0 (11·0)
USA	Denver (CO)	1992-2006	23·8 (5·2)	25·1 (13·5)	10·5 (9·6)
USA	Detroit (MI)	1990-2006	90·9 (12·0)	32·2 (19·8)	10·7 (10·3)
USA	Las Vegas (NV)	1995-2006	28·2 (8·5)	32·8 (16·4)	20·9 (9·5)
USA	Madison (IL)	1994-2006	6·1 (2·6)	35·3 (20·0)	14·1 (10·2)
USA	New Haven (CT)	1988-2004	19·6 (4·9)	25·4 (15·6)	12·0 (9·3)
USA	Ottawa (IL)	1995-2006	3·2 (1·8)	26·4 (16·8)	10·2 (11·0)
USA	Pittsburgh (PA)	1987-2006	39·5 (7·3)	28·8 (19·2)	11·3 (9·8)
USA	Provo (UT)	1993-2006	3·8 (2·0)	29·1 (17·9)	10·3 (9·7)
USA	Salt Lake City (UT)	1988-2006	11·5 (3·7)	33·7 (21·7)	11·8 (10·4)
USA	Spokane (WA)	1993-2006	8·9 (3·1)	24·4 (17·4)	9·7 (8·6)

eTable 2. Results of the longitudinal random-effects meta-regression model using two explanatory variables. Based on a model that includes calendar year and the percentage of the population aged 65 and over, we added an additional variable and tested its significance. Results are expressed as the change in the PM_{10}-mortality risk per one standard deviation increase in the explanatory variable.

Variable	Percent change in PM_{10}-mortality risk (95% CI)	P-for LRT
Model 1: Calendar year + percentage of population aged ≥ 65 + per capita GDP		
Calendar year	-0·0011 (-0·0085 to 0·0063)	
Percentage of population aged ≥ 65	0·098 (0·011 to 0·186)	
Per capita GDP	0·033 (-0·021 to 0·086)	0·24
Model 2: Calendar year + percentage of population aged ≥ 65 + population number		
Calendar year	0·0005 (-0·0059 to 0·0069)	
Percentage of population aged ≥ 65	0·120 (0·034 to 0·205)	
Population number	0·016 (0·000 to 0·032)	0·05
Model 3: Calendar year + percentage of population aged ≥ 65 + PM10concentration		
Calendar year	0·0008 (-0·0056 to 0·0073)	
Percentage of population aged ≥ 65	0·086 (-0·008 to 0·180)	
PM10concentration	-0·041 (-0·107 to 0·026)	0·25
Model 4: Calendar year + percentage of population aged ≥ 65 + temperature		
Calendar year	0·0003 (-0·0065 to 0·0070)	
Percentage of population aged ≥ 65	0·123 (0·034 to 0·213)	
Temperature	0·049 (-0·064 to 0·161)	0·40
Model 5: Calendar year + percentage of population aged ≥ 65 + EVI		
Calendar year	-0·0010 (-0·0078 to 0·0057)	
Percentage of population aged ≥ 65	0·128 (0·043 to 0·213)	
EVI	-0·053 (-0·115 to 0·009)	0·10

eTable 3. Results of longitudinal random effect meta-regression model by different random effect terms (bold indicates model used in the main result).

Model	Percent change in PM_{10}-mortality risk (95% CI)	P for LRT*
Random intercept by city	0·0063 (0·0016 to 0·0109)	Reference
Random intercept by country	0·0068 (0·0021 to 0·0114)	-
Random intercept by city + country	**0·0069 (0·0022 to 0·0117)**	**<0·01**

*Likelihood ratio test

eTable 4. Results of longitudinal random effect meta-regression model by different time windows (bold indicates model used in the main result).

Time window	Percent change in PM_{10}-mortality risk (95% CI)
3 years	**0·0069 (0·0022 to 0·0117)**
4 years	0·0067 (0·0020 to 0·0115)
5 years	0·0068 (0·0020 to 0·0115)

eTable 5. Results of longitudinal random effect meta-regression model by different degrees of freedom in temperature-mortality association (bold indicates model used in the main result).

Degree of freedom	Percent change in PM_{10}-mortality risk (95% CI)
4	0·0073 (0·0025 to 0·0120)
5	0·0069 (0·0021 to 0·0116)
6	**0·0069 (0·0022 to 0·0117)**

eTable 6. Model comparison between linear and non-linear models for modeling temporal trends in mortality effects of PM_{10}

Model	Log-likelihood	Degrees of freedom	P-value
Linear model*	2518·8	4	-
Non-linear model**	2519·3	5	0·29

* The linear model includes only the year as the independent variable.
** The non-linear model includes both the year and its squared term (year + I(year^2)) as independent variables.

eTable 7. City-specific results for temporal change in PM_{10} mortality risk in 143 cities across 26 countries.

Country	City	Period	Percent increase in PM_{10}-mortality risk per year
Canada	Regina	2001-2011	0·1327 (-0·4814 to 0·7506)
Canada	Victoria	2001-2011	-0·2440 (-1·0193 to 0·5373)
Canada	Winnipeg	2000-2011	0·0498 (-0·3983 to 0·5000)
Chile	Temuco	2004-2012	0·0832 (-0·1632 to 0·3302)
Chile	Valparaiso	2004-2013	-0·0799 (-0·4641 to 0·3058)
Colombia	Bogota	2002-2013	-0·0550 (-0·1731 to 0·0633)
Cyprus	Famagusta	2010-2019	-0·5131 (-1·3186 to 0·2990)
Cyprus	Larnaka	2005-2019	-0·0004 (-0·1605 to 0·1599)
Cyprus	Limassol	2005-2019	0·0251 (-0·0963 to 0·1467)
Cyprus	Nicosia	2005-2019	-0·0635 (-0·1646 to 0·0377)
Cyprus	Pafos	2005-2019	0·0234 (-0·1904 to 0·2377)
Czech Republic	Prague	1994-2009	-0·0030 (-0·0657 to 0·0599)
Ecuador	Quito	2014-2019	-0·2074 (-0·8473 to 0·4366)
Estonia	Kohtla-Jarve Linn	2003-2019	0·1499 (-0·4925 to 0·7964)
Estonia	Narva Linn	2009-2019	-0·0508 (-1·3797 to 1·2961)
Estonia	Tallinn	2005-2019	0·0179 (-0·1769 to 0·2131)
Estonia	Tartu Linn	2009-2019	0·8585 (0·0289 to 1·6949)
Finland	Helsinki	1994-2014	-0·0427 (-0·1222 to 0·0368)
France	Bordeaux	2000-2017	-0·0154 (-0·2141 to 0·1837)
France	Clermont-Ferrand	2000-2017	-0·1461 (-0·4244 to 0·1331)
France	Dijon	2000-2017	-0·1717 (-0·4960 to 0·1537)
France	Grenoble	2000-2017	-0·1480 (-0·3519 to 0·0563)
France	Le Havre	2000-2017	-0·1390 (-0·4112 to 0·1340)
France	Lens-Douai	2000-2017	0·0833 (-0·1133 to 0·2802)
France	Lille	2000-2017	0·0710 (-0·0545 to 0·1966)
France	Lyon	2000-2017	-0·1721 (-0·2959 to -0·0482)
France	Marseille	2000-2017	-0·0642 (-0·2081 to 0·0800)
France	Montpellier	2000-2017	-0·0482 (-0·2959 to 0·2001)
France	Nancy	2000-2017	0·0873 (-0·1373 to 0·3124)
France	Nantes	2000-2017	-0·1250 (-0·3990 to 0·1497)
France	Nice	2002-2017	0·3194 (0·0291 to 0·6107)
France	Orleans	2000-2017	-0·0610 (-0·3772 to 0·2561)
France	Paris	2000-2017	-0·1691 (-0·2340 to -0·1042)
France	Rennes	2000-2015	-0·0838 (-0·5239 to 0·3582)
France	Rouen	2000-2017	-0·1714 (-0·3850 to 0·0427)
France	Strasbourg	2000-2017	-0·2741 (-0·4775 to -0·0703)
France	Toulouse	2000-2017	-0·1886 (-0·4005 to 0·0237)
France	Tours	2000-2017	-0·4422 (-0·8267 to -0·0562)
Germany	Berlin	2002-2019	-0·0248 (-0·0783 to 0·0287)
Germany	Bremen	2003-2019	-0·0856 (-0·2572 to 0·0862)
Germany	Dortmund	2003-2019	0·0427 (-0·0983 to 0·1838)
Germany	Dresden	2003-2019	-0·0019 (-0·1450 to 0·1413)
Germany	Dusseldorf	2004-2015	0·1560 (-0·1127 to 0·4255)
Germany	Essen	2003-2019	0·0965 (-0·0303 to 0·2235)
Germany	Frankfurt	2000-2019	-0·0381 (-0·1574 to 0·0813)
Germany	Hamburg	2001-2019	-0·0070 (-0·0751 to 0·0610)
Germany	Hannover	2001-2015	-0·0076 (-0·1203 to 0·1052)
Germany	Koeln	2003-2019	-0·1018 (-0·2396 to 0·0362)
Germany	Leipzig	2003-2019	0·0016 (-0·1521 to 0·1556)
Germany	Munich	2000-2019	0·0055 (-0·0620 to 0·0731)
Germany	Stuttgart	2000-2019	-0·0062 (-0·1371 to 0·1249)
Greece	Athens	2001-2010	0·0550 (-0·0501 to 0·1601)
Iceland	Reykjavik	2002-2018	0·2972 (0·0639 to 0·5309)
Iran	Tehran	2002-2012	0·0220 (-0·0136 to 0·0575)
Israel	Beer Sheva	2001-2019	0·0162 (-0·0391 to 0·0716)
Israel	Haifa	2000-2019	0·0049 (-0·0280 to 0·0379)
Israel	Jerusalem	2002-2019	0·0073 (-0·0245 to 0·0390)
Israel	Tel Aviv	2000-2019	-0·0080 (-0·0259 to 0·0099)
Italy	Ancona	2006-2014	0·4614 (-0·4410 to 1·3720)

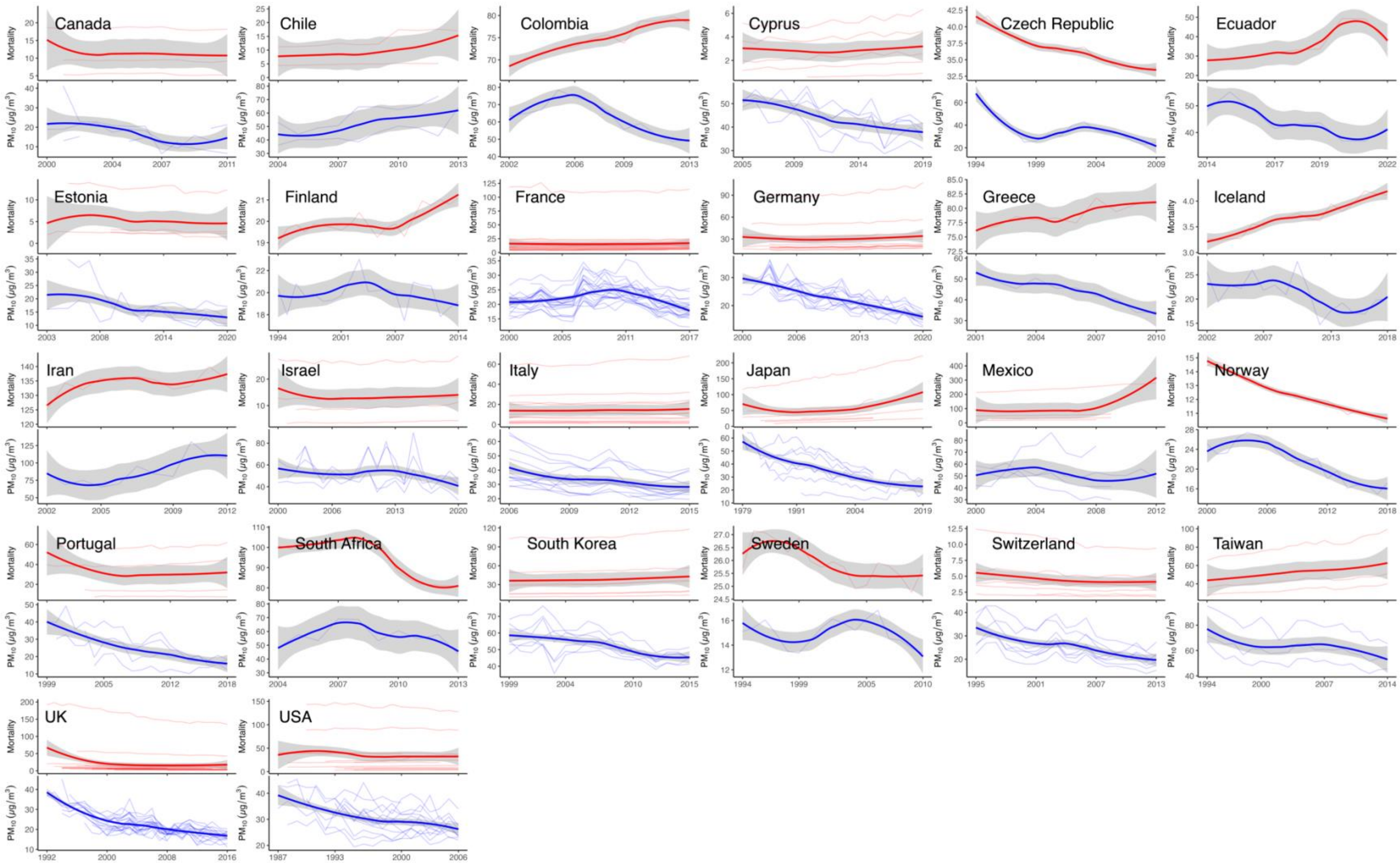
Italy	Bari	2006-2015	-0·0706 (-0·6773 to 0·5399)
Italy	Bologna	2006-2015	-0·0094 (-0·3299 to 0·3122)
Italy	Cagliari	2006-2015	0·3650 (-0·4749 to 1·2120)
Italy	Florence	2006-2015	0·0672 (-0·3279 to 0·4640)
Italy	Frosinone	2006-2015	-0·8223 (-1·4722 to -0·1681)
Italy	Genoa	2006-2015	0·1386 (-0·2789 to 0·5578)
Italy	Latina	2006-2015	0·7711 (-0·0857 to 1·6351)
Italy	Milan	2006-2015	-0·0444 (-0·1765 to 0·0878)
Italy	Rome	2006-2015	0·0541 (-0·1204 to 0·2289)
Italy	Trieste	2006-2015	-0·1291 (-0·5315 to 0·2750)
Italy	Turin	2006-2015	0·0556 (-0·0831 to 0·1945)
Italy	Viterbo	2006-2015	-1·0248 (-2·4260 to 0·3966)
Japan	Fukuoka	1984-2008	0·0481 (-0·0060 to 0·1023)
Japan	Kitakyushu	1983-2008	0·0350 (-0·0084 to 0·0785)
Japan	Nagoya	1979-2008	0·0039 (-0·0205 to 0·0283)
Japan	Osaka	1980-2008	-0·0098 (-0·0293 to 0·0098)
Japan	Sapporo	1992-2019	0·0272 (-0·0390 to 0·0934)
Japan	Sendai	1986-2019	0·0211 (-0·0327 to 0·0749)
Japan	Tokyo	1979-2019	0·0150 (0·0068 to 0·0231)
Mexico	Guadalajara	2000-2009	0·2225 (0·0307 to 0·4147)
Mexico	Puebla-Tlaxcala	2001-2009	0·2848 (-0·0371 to 0·6077)
Mexico	Toluca de Lerdo	2000-2008	0·1003 (-0·1673 to 0·3687)
Mexico	Valley of Mexico	2000-2012	-0·0095 (-0·0620 to 0·0431)
Norway	Oslo	2000-2018	-0·1034 (-0·2689 to 0·0624)
Portugal	Castelobranco	2004-2018	0·2809 (-0·0335 to 0·5964)
Portugal	Coimbra	2003-2018	0·0337 (-0·1613 to 0·2290)
Portugal	Lisboa	2000-2018	0·1168 (0·0461 to 0·1875)
Portugal	Porto	1999-2018	0·0758 (0·0141 to 0·1376)
South Africa	City of Johannesburg	2004-2013	-0·0975 (-0·2058 to 0·0109)
South Korea	Busan	1999-2015	0·0110 (-0·0303 to 0·0522)
South Korea	Daegu	1999-2015	0·0953 (0·0437 to 0·1470)
South Korea	Daejeon	1999-2015	0·0173 (-0·0518 to 0·0865)
South Korea	Gwangju	1999-2015	0·0276 (-0·0420 to 0·0973)
South Korea	Incheon	1999-2015	-0·0244 (-0·0690 to 0·0204)
South Korea	Seoul	1999-2015	-0·0007 (-0·0218 to 0·0204)
South Korea	Ulsan	1999-2015	0·0125 (-0·0847 to 0·1097)
Sweden	Stockholm	1994-2010	0·0075 (-0·1975 to 0·2128)
Switzerland	Basel	1995-2013	0·1241 (-0·0788 to 0·3275)
Switzerland	Bern	1995-2013	-0·0715 (-0·2963 to 0·1538)
Switzerland	Geneve	1998-2013	-0·0475 (-0·3439 to 0·2498)
Switzerland	Lausanne	1995-2013	-0·1805 (-0·4051 to 0·0447)
Switzerland	Lugano	1995-2013	-0·0689 (-0·2473 to 0·1098)
Switzerland	Luzern	2001-2013	0·0229 (-0·5731 to 0·6224)
Switzerland	St. Gallen	1995-2013	0·0327 (-0·3192 to 0·3857)
Switzerland	Zürich	1995-2013	-0·0722 (-0·2091 to 0·0648)
Taiwan	Kaohsiung	1994-2014	0·0155 (-0·0174 to 0·0484)
Taiwan	Taichung	1994-2014	-0·0229 (-0·0568 to 0·0110)
Taiwan	Taipei	1994-2014	0·0147 (-0·0112 to 0·0407)
UK	Birkenhead	2000-2008	-0·1692 (-0·9399 to 0·6075)
UK	Bristol	1993-2016	0·0388 (-0·0711 to 0·1488)
UK	Cardiff	1994-2016	0·0655 (-0·0981 to 0·2293)
UK	Chesterfield	2008-2016	-0·2479 (-1·7166 to 1·2427)
UK	Crawley	2001-2016	-0·0465 (-0·6107 to 0·5210)
UK	Eastbourne	2001-2016	-0·1307 (-0·6899 to 0·4317)
UK	Kingston upon Hull	1994-2014	0·0102 (-0·1630 to 0·1836)
UK	Leicester	1994-2013	0·0543 (-0·1260 to 0·2349)
UK	London	1992-2016	0·0024 (-0·0272 to 0·0319)
UK	Manchester	1996-2016	-0·0054 (-0·0730 to 0·0622)
UK	Medway Towns	1997-2009	0·5578 (0·0670 to 1·0511)
UK	Newport	2002-2016	0·0201 (-0·5223 to 0·5654)
UK	Nottingham	1997-2016	0·0305 (-0·1152 to 0·1764)
UK	Plymouth	1998-2016	0·2436 (-0·0738 to 0·5622)

UK	Preston	2000-2008	-0·0207 (-1·1191 to 1·0899)
UK	Reading	1998-2016	-0·0902 (-0·4018 to 0·2224)
UK	Sheffield	1996-2016	0·0053 (-0·1104 to 0·1211)
UK	Southampton	1994-2006	-0·1359 (-0·5119 to 0·2415)
UK	Southend-on-Sea	2000-2008	0·8772 (0·0404 to 1·7210)
UK	Stoke-on-Trent	1998-2014	-0·2355 (-0·5004 to 0·0300)
UK	Swansea	1995-2016	0·1253 (-0·0930 to 0·3441)
UK	Tyneside	1992-2016	-0·0252 (-0·1163 to 0·0659)
UK	York	2008-2016	-0·4019 (-1·7509 to 0·9657)
USA	Cleveland (OH)	1987-2000	0·0033 (-0·0941 to 0·1009)
USA	Chicago (IL)	1990-2006	0·0343 (-0·0145 to 0·0831)
USA	Davenport (IA)	1996-2006	0·2687 (-0·0479 to 0·5864)
USA	Denver (CO)	1992-2006	0·0311 (-0·1238 to 0·1863)
USA	Detroit (MI)	1990-2006	-0·0319 (-0·0787 to 0·0149)
USA	Las Vegas (NV)	1995-2006	0·1053 (-0·0935 to 0·3045)
USA	Madison (IL)	1994-2006	0·1146 (-0·1365 to 0·3664)
USA	New Haven (CT)	1988-2004	-0·0868 (-0·2121 to 0·0386)
USA	Ottawa (IL)	1995-2006	-0·0934 (-0·5407 to 0·3559)
USA	Pittsburgh (PA)	1987-2006	0·0057 (-0·0435 to 0·0550)
USA	Provo (UT)	1993-2006	-0·0046 (-0·3350 to 0·3270)
USA	Salt Lake City (UT)	1988-2006	0·0586 (-0·0352 to 0·1525)
USA	Spokane (WA)	1993-2006	0·2237 (0·0299 to 0·4178)

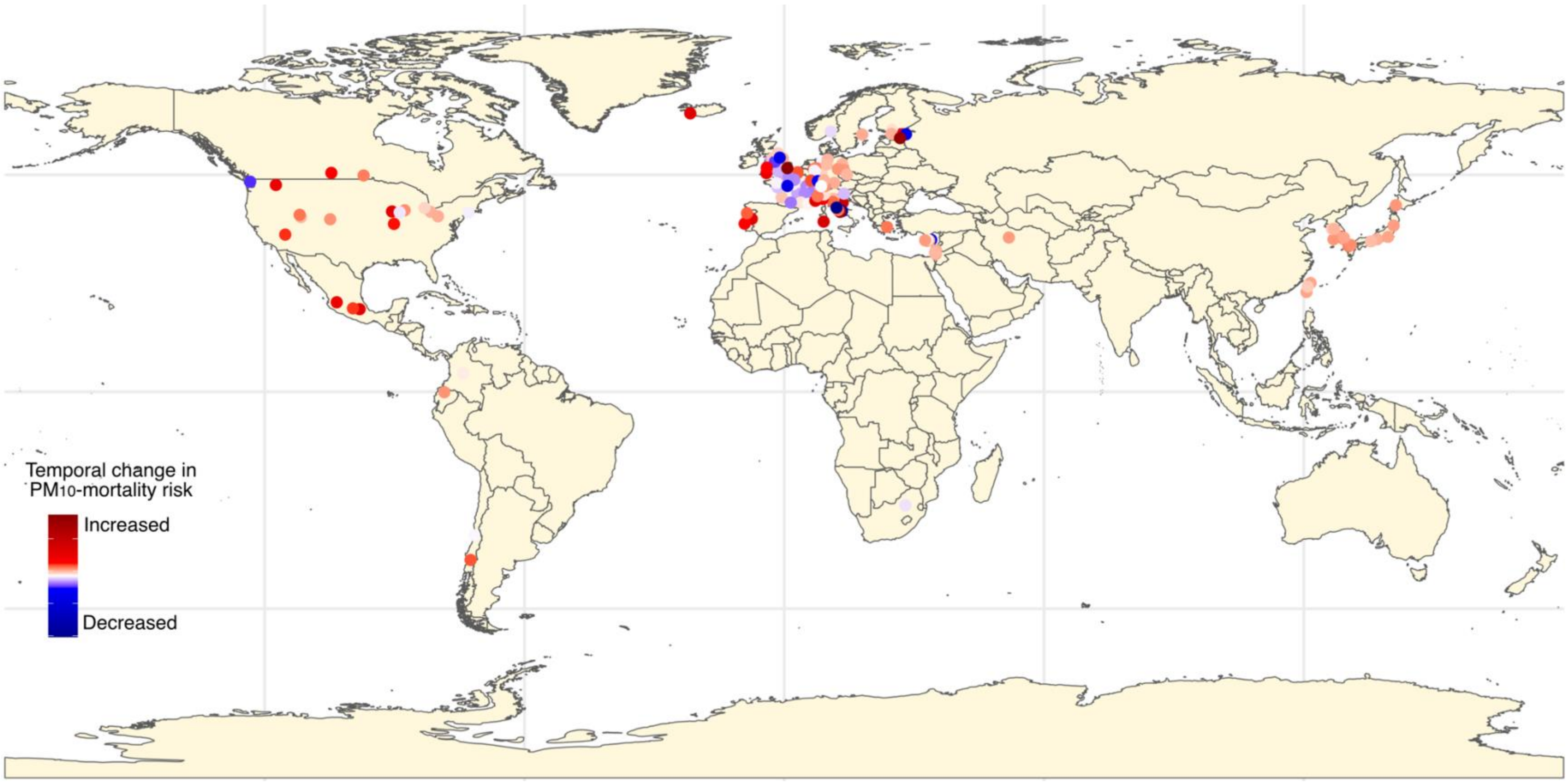
eTable 8. Correlation coefficients between explanatory variables.

		Per capita GDP	Population number	Percentage of population aged ≥ 65	PM_{10} concentration	Temperature	EVI
Between city	Per capita GDP	1·00					
	Population number	-0·14	1·00				
	Percentage of population aged ≥ 65	0·32	0·08	1·00			
	PM10concentration	-0·44	0·19	-0·61	1·00		
	Temperature	-0·39	0·25	-0·31	0·69	1·00	
	EVI	-0·01	-0·07	0·20	-0·19	-0·03	1·00
Within city	Per capita GDP	1·00					
	Population number	0·40	1·00				
	Percentage of population aged ≥ 65	0·40	0·45	1·00			
	PM_{10} concentration	-0·46	-0·39	-0·44	1·00		
	Temperature	0·31	0·15	0·28	-0·32	1·00	
	EVI	-0·44	-0·08	-0·26	0·11	-0·13	1·00

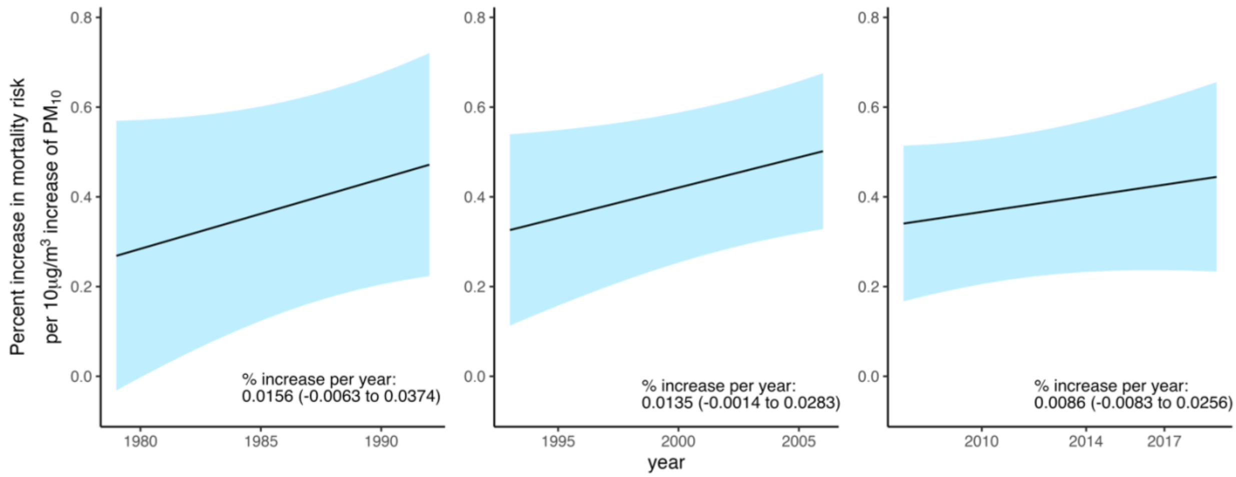
Units of the variables are as follows: Units of the variables are as follows. Per capita GDP is measured in US dollars per person. Population number is the total count of residents. The percentage of the population aged 65 years or older is expressed as a percent. PM_{10} concentration is measured in µg/m³. Temperature is measured in °C. EVI is a unitless index ranging from 0 to 1.



eFigure 1. Temporal trends in the daily average mortality counts and ambient PM_{10} concentration in the study area. The bolded line represents the average trend with 95% confidence interval, and the lighter lines represent trends in each city.

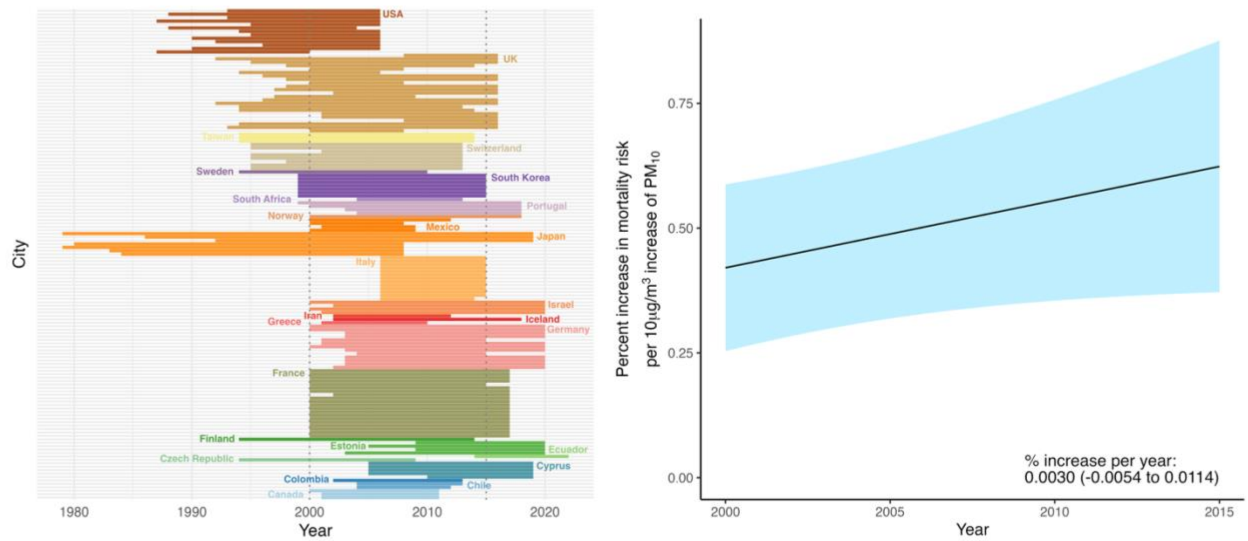


eFigure 2. Geographic distribution of the study cities and city-specific temporal trends in PM_{10}–mortality risk across 143 cities in 26 countries.



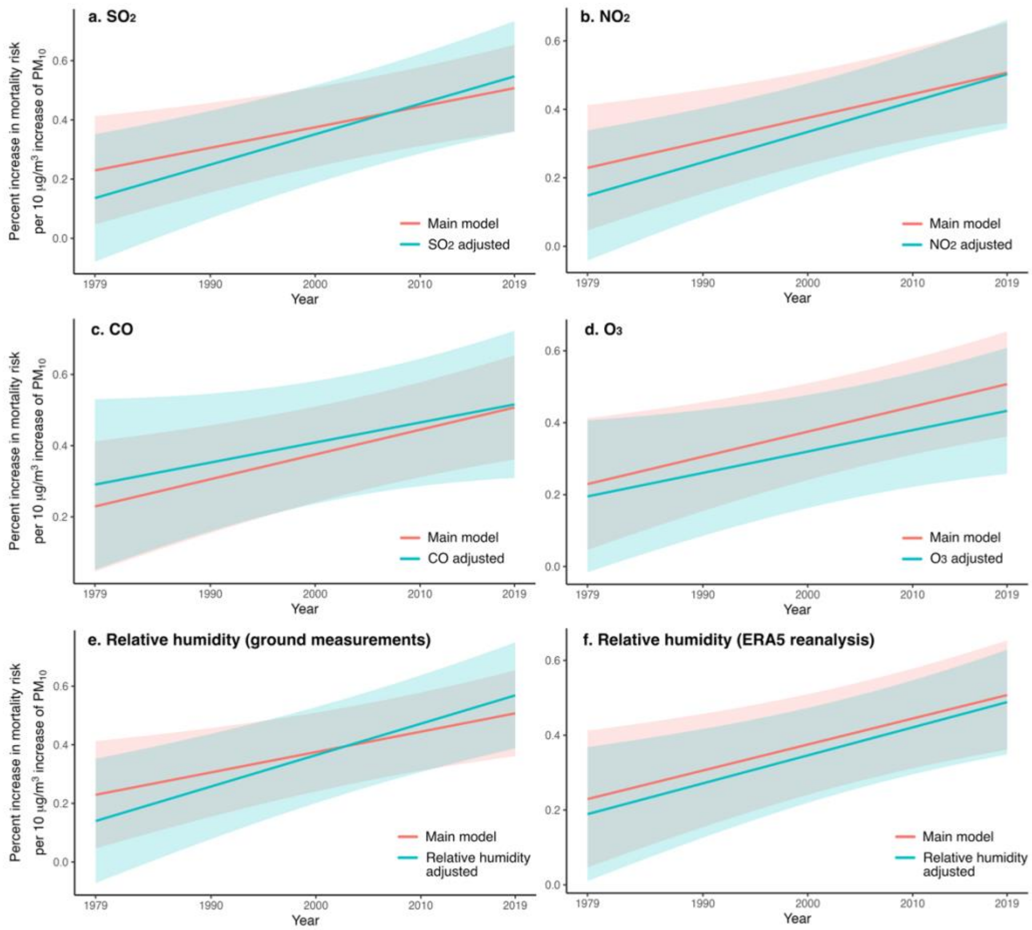
eFigure 3. Temporal trend in the effects of PM_{10} and their on all-cause mortality, stratified by three different study periods (1979-1992, 1993-2006, 2007-2019).

The number in the plot represents the percent change in PM_{10}-mortality risk per year, along with their 95% confidence intervals.



eFigure 4. Temporal trend in the effects of PM_{10} on all-cause mortality during the most common study period (2000–2015).

The left panel shows the study periods available for each city included in the analysis, and the right panel presents the temporal trend for 2000–2015, which represents the most common study period across all locations. The number in the right plot represents the percent change in PM_{10}-mortality risk per year, along with their 95% confidence intervals.



eFigure 5. Temporal trend in the PM_{10}–mortality association, adjusted for SO_2 (a), NO_2 (b), CO (c), O_3 (d), relative humidity (ground measurements) (e), and relative humidity (ERA-5 Land reanalysis[12]) (f).

Included cities:

SO_2 (86 cities across 18 countries): Canada (Regina, Victoria, Winnipeg), Colombia (Bogota), Czech Republic (Prague), Ecuador (Quito), Estonia (Kohtla-Jarve linn, Narva linn, Tallinn, Tartu linn), Finland (Helsinki), Germany (Berlin, Bremen, Dortmund, Dresden, Dusseldorf, Essen, Frankfurt, Hamburg, Hannover, Koeln, Leipzig, Munich, Stuttgart), Greece (Athens), Iran (Tehran), Israel (Beer Sheva, Haifa, Jerusalem, Tel Aviv), Japan (Fukuoka, Kitakyushu, Nagoya, Osaka, Sapporo, Sendai, Tokyo), Portugal (Castelobranco, Coimbra, Lisboa, Porto), South Korea (Busan, Daegu, Daejeon, Gwangju, Incheon, Seoul, Ulsan), Sweden (Stockholm), Switzerland (Basel, Bern, Geneve, Lausanne, Lugano, Luzern, St. Gallen, Zürich), Taiwan (Kaohsiung, Taichung, Taipei), UK (Bristol, Cardiff, Chesterfield, Crawley, Eastbourne, Kingston upon Hull, Leicester, London, Manchester, Medway Towns, Newport, Nottingham, Reading, Sheffield, Southend-on-Sea, Stoke-on-Trent, Swansea), USA (chicago (IL), Cleveland, denver (CO), detroit (MI), las vegas (NV), new haven (CT), pittsburgh (PA), provo (UT), salt lake city (UT))

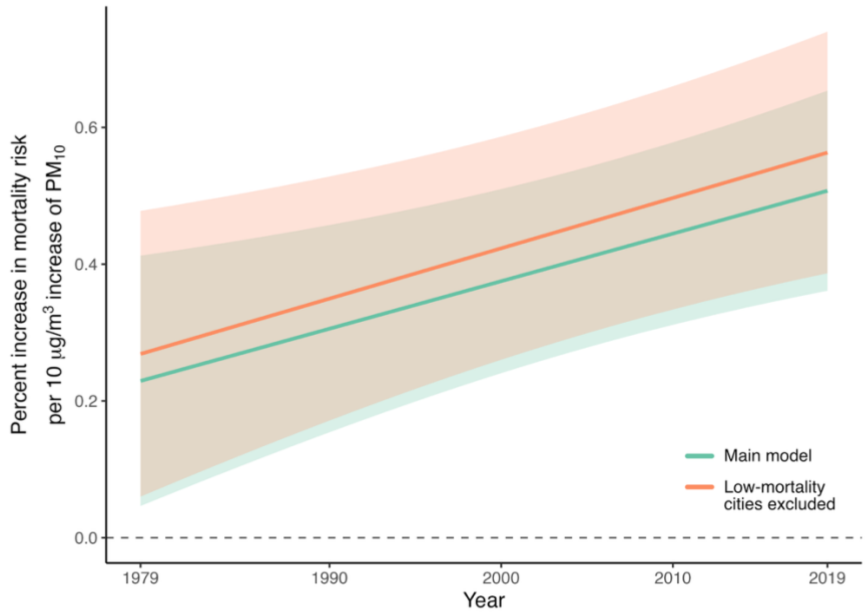
NO_2 (61 cities across 15 countries): Canada (Regina, Victoria, Winnipeg), Colombia (Bogota), Czech Republic (Prague), Ecuador (Quito), Estonia (Kohtla-Jarve linn, Narva linn, Tallinn, Tartu linn), Finland (Helsinki), Germany (Berlin, Bremen, Dortmund, Dresden, Dusseldorf, Essen, Frankfurt, Hamburg, Hannover, Koeln, Leipzig, Munich, Stuttgart), Greece (Athens), Iran (Tehran), Israel (Beer Sheva, Haifa, Jerusalem, Tel Aviv), Japan (Fukuoka, Kitakyushu, Nagoya, Osaka, Sapporo, Sendai, Tokyo), Portugal (Castelobranco, Coimbra, Lisboa, Porto), South Korea (Busan, Daegu, Daejeon, Gwangju, Incheon, Seoul, Ulsan), Sweden (Stockholm), Switzerland (Basel, Bern, Geneve, Lausanne, Lugano, Luzern, St. Gallen, Zürich), Taiwan (Kaohsiung, Taichung, Taipei), UK (Bristol, Cardiff, Chesterfield, Crawley, Eastbourne, Kingston upon Hull, Leicester, London, Manchester, Medway Towns, Newport, Nottingham, Reading, Sheffield, Southend-on-Sea, Stoke-on-Trent, Swansea), USA (chicago (IL), Cleveland, denver (CO), detroit (MI), las vegas (NV), new haven (CT), pittsburgh (PA), provo (UT), salt lake city (UT))

CO (48 cities across 14 countries): Canada (Regina, Winnipeg), Chile (Temuco), Ecuador (Quito), Finland (Helsinki), Germany (Munich), Iran (Tehran), Japan (Kitakyushu, Nagoya, Osaka, Tokyo), Portugal (Lisboa), South Korea (Busan, Daegu, Daejeon, Gwangju, Incheon, Seoul, Ulsan), Sweden (Stockholm), Switzerland (Bern, Lausanne, Lugano, Zürich), Taiwan (Kaohsiung, Taichung, Taipei), UK (Birkenhead, Bristol, Cardiff, Kingston upon Hull, Leicester, London, Manchester, Medway Towns, Preston, Southend-on-Sea, Tyneside), USA (chicago (IL), Cleveland, denver (CO), detroit (MI), las vegas (NV), new haven (CT), pittsburgh (PA), provo (UT), salt lake city (UT), spokane (WA))

O_3 (67 cities across 15 countries): Canada (Regina, Victoria, Winnipeg), Chile (Valparaiso), Colombia (Bogota), Ecuador (Quito), Finland (Helsinki), France (Orleans, Tours), Germany (Berlin, Bremen, Dortmund, Dresden, Dusseldorf, Frankfurt, Hamburg, Hannover, Koeln, Leipzig, Munich, Stuttgart), Iran (Tehran), Israel (Beer Sheva, Haifa, Jerusalem, Tel Aviv), Japan (Fukuoka, Kitakyushu, Nagoya, Osaka, Sendai, Tokyo), Portugal (Castelobranco, Coimbra, Lisboa, Porto), South Korea (Busan, Daegu, Daejeon, Gwangju, Incheon, Seoul, Ulsan), Taiwan (Kaohsiung, Taichung, Taipei), UK (Bristol, Cardiff, Eastbourne, Kingston upon Hull, Leicester, London, Manchester, Medway Towns, Newport, Nottingham, Preston, Reading, Sheffield, Southend-on-Sea, Stoke-on-Trent, Swansea), USA (chicago (IL), denver (CO), las vegas (NV), madison (IL), pittsburgh (PA))

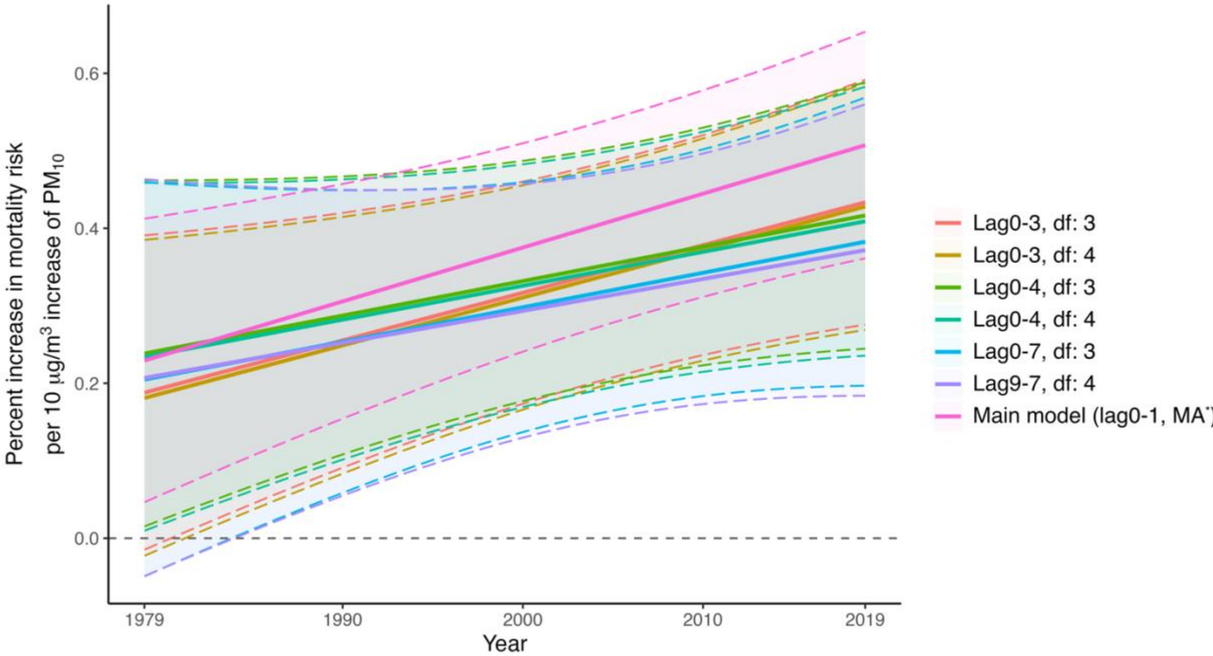
Relative humidity (ground measurements; 75 cities across 18 countries): Canada (Regina, Victoria, Winnipeg), Chile (Temuco, Valparaiso), Cyprus (famagusta, larnaka, limassol, nicosia, pafos), Czech Republic (Prague), Estonia (Kohtla-Jarve linn, Narva linn, Tallinn, Tartu linn), Finland (Helsinki), Germany (Berlin, Bremen, Dortmund, Dresden, Dusseldorf, Essen, Frankfurt, Hamburg, Hannover, Koeln, Leipzig, Munich, Stuttgart), Greece (Athens), Iran (Tehran), Japan (Fukuoka, Kitakyushu, Nagoya, Osaka, Sapporo, Sendai, Tokyo), Mexico (Guadalajara, Puebla-Tlaxcala, Toluca de Lerdo, Valley of Mexico), Norway (Oslo), South Korea (Busan, Daegu, Daejeon, Gwangju, Incheon, Seoul, Ulsan), Sweden (Stockholm), Switzerland (Basel, Bern, Geneve, Lausanne, Lugano, Luzern, St. Gallen, Zürich), Taiwan (Kaohsiung, Taichung, Taipei), UK (Southampton), USA (chicago (IL), Cleveland, davenport (IA), denver (CO), detroit (MI), las vegas (NV), madison (IL), ottawa (IL), pittsburgh (PA), provo (UT), salt lake city (UT), spokane (WA))

Relative humidity (ERA5 reanalysis): All cities included in the main analysis



eFigure 6. Temporal trend in the PM_{10}–mortality association after excluding cities with average daily mortality ≤20.

Included cities (46 cities across 19 countries): Colombia (Bogota), Czech Republic (Prague), Ecuador (Quito), France (Lille, Marseille, Paris), Germany (Berlin, Essen, Hamburg, Hannover, Koeln, Munich), Greece (Athens), Iran (Tehran), Israel (Tel Aviv), Italy (Genoa, Milan, Rome, Turin), Japan (Kitakyushu, Nagoya, Osaka, Sapporo, Tokyo), Mexico (Guadalajara, Puebla-Tlaxcala, Valley of Mexico), Portugal (Lisboa, Porto), South Africa (City of Johannesburg), South Korea (Busan, Daegu, Incheon, Seoul), Sweden (Stockholm), Taiwan (Kaohsiung, Taichung, Taipei), UK (London, Manchester), USA (Cleveland, chicago (IL), denver (CO), detroit (MI), las vegas (NV), pittsburgh (PA)).



eFigure 7. Temporal trend in the PM_{10}–mortality association by different lag period.

*MA denotes moving average.
Lag 0–x represents the cumulative lag effect from the day of exposure up to x days.
The lag–response relationship was modelled using a natural cubic spline with 3 or 4 degrees of freedom (df).

References

1. Chen G, Guo Y, Yue X, et al. Mortality risk attributable to wildfire-related PM(2.5) pollution: a global time series study in 749 locations. *Lancet Planet Health*. Sep 2021;5(9):e579-e587. doi:10.1016/S2542-5196(21)00200-X
2. Guo Y, Gasparrini A, Armstrong B, et al. Global variation in the effects of ambient temperature on mortality: a systematic evaluation. *Epidemiology*. Nov 2014;25(6):781-9. doi:10.1097/EDE.0000000000000165
3. Liu C, Cai J, Chen R, et al. Coarse Particulate Air Pollution and Daily Mortality: A Global Study in 205 Cities. *Am J Respir Crit Care Med*. Oct 15 2022;206(8):999-1007. doi:10.1164/rccm.202111-2657OC
4. Liu C, Chen R, Sera F, et al. Ambient Particulate Air Pollution and Daily Mortality in 652 Cities. *N Engl J Med*. Aug 22 2019;381(8):705-715. doi:10.1056/NEJMoa1817364
5. Liu C, Chen R, Sera F, et al. Interactive effects of ambient fine particulate matter and ozone on daily mortality in 372 cities: two stage time series analysis. *BMJ*. Oct 4 2023;383:e075203. doi:10.1136/bmj-2023-075203
6. Masselot P, Kan H, Kharol SK, et al. Air pollution mixture complexity and its effect on PM(2.5)-related mortality: A multicountry time-series study in 264 cities. *Environ Epidemiol*. Dec 2024;8(6):e342. doi:10.1097/EE9.0000000000000342
7. Masselot P, Sera F, Schneider R, et al. Differential Mortality Risks Associated With PM2.5 Components: A Multi-Country, Multi-City Study. *Epidemiology*. Mar 1 2022;33(2):167-175. doi:10.1097/EDE.0000000000001455
8. Rai M, Stafoggia M, de'Donato F, et al. Heat-related cardiorespiratory mortality: Effect modification by air pollution across 482 cities from 24 countries. *Environ Int*. Apr 2023;174:107825. doi:10.1016/j.envint.2023.107825
9. Schwarz M, Peters A, Stafoggia M, et al. Temporal variations in the short-term effects of ambient air pollution on cardiovascular and respiratory mortality: a pooled analysis of 380 urban areas over a 22-year period. *Lancet Planet Health*. Sep 2024;8(9):e657-e665. doi:10.1016/S2542-5196(24)00168-2
10. Stafoggia M, Michelozzi P, Schneider A, et al. Joint effect of heat and air pollution on mortality in 620 cities of 36 countries. *Environ Int*. Nov 2023;181:108258. doi:10.1016/j.envint.2023.108258
11. Yu W, Huang W, Gasparrini A, et al. Ambient fine particulate matter and daily mortality: a comparative analysis of observed and estimated exposure in 347 cities. *Int J Epidemiol*. Apr 11 2024;53(3)doi:10.1093/ije/dyae066
12. Muñoz-Sabater J, Dutra E, Agustí-Panareda A, et al. ERA5-Land: A state-of-the-art global reanalysis dataset for land applications. *Earth system science data*. 2021;13(9):4349-4383.