Climate change and the projected burden of future health impacts - The Project EXHAUSTION

Der Klimawandel und seine zukünftigen Gesundheitsfolgen - Das Projekt EXHAUSTION

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Abstract: Climate change, foreseen to cause adverse effects on human health, is one of the greatest threats of the century. Several studies have projected an increasing burden of health effects in the future attributable to climate change. Nevertheless, research in this field is comparatively young and so far there are no concrete answers. This article discusses existing research gaps and introduces the EU project EXHAUSTION which aims to fill at least some of them.

Keywords: climate change, cardiopulmonary disease, air pollution, adaptation, mitigation

Zusammenfassung: Der Klimawandel, eine der größten Bedrohungen des Jahrhunderts, wird voraussichtlich einen negativen Einfluss auf die menschliche Gesundheit haben. Mehrere Studien haben prognostiziert, dass die gesundheitlichen Auswirkungen des Klimawandels in Zukunft zunehmen werden. Dennoch ist die Forschung auf diesem Gebiet vergleichsweise jung und es scheint bisher keine konkreten Antworten zu geben. Dieser Artikel diskutiert bestehende Forschungslücken und stellt das EU-Projekt EXHAUSTION vor, das darauf abzielt, zumindest einige davon zu schließen.

Schlüsselwörter: Klimawandel, kardiopulmonale Erkrankungen, Luftschadstoffe, Adaptation, Mitigation

Climate change poses significant challenges to human health. Under a warming climate, an increasing trend in the frequency and intensity of extreme weather events is detected, which have been associated with higher risks of morbidity and mortality [1, 2]. For example, due to intense heat waves, over 70,000 excess deaths occurred across Europe during the summer of 2003 [3]. However, temperature-related health effects are not restricted to extreme weather. Epidemiological studies have demonstrated that the temperature-mortality relationship is generally non-linear, showing a U- or J-shaped pattern, with increasing risks above or below a geographically dependent optimum temperature [4]. Moreover, moderate non-optimum temperatures may outweigh the

mortality burden attributable to extreme weather because of their high frequencies [4]. Thus, examining the temperature-health relationship across the whole temperature range is essential for the assessment of temperature-related impact, especially on morbidity which is yet to be fully investigated.

The time course of the temperature-health relationship is characterized by an immediate heat effect occurring within a few days and a delayed cold effect lasting up to several weeks [5]. Given the changing pattern of climate, it is important to understand longer-term effects of annual or seasonal mean temperatures. A higher annual mean temperature has been associated with an increased prevalence of respiratory allergies [6]. Positive associations were also observed for summer mean temperature and temperature variability with mortality risk [7]. Besides, studies have shown that years with a greater frequency and severity of high and low temperatures tend to have higher mortality than years with rather moderate daily temperatures [8, 9]. Such findings in an annual timeframe indicate a significant life shortening associated with temperature, rather than a result of just short-term mortality displacement. Apart from the temperature effect, recent studies highlight the synergistic effects of temperature and air pollution on total and cardiovascular mortality, with stronger temperature-mortality associations at higher exposure levels of ozone (O_3) or particulate matter, including also long-term effects [10-12]. Moreover, climate change may in itself worsen air quality through a diverse set of mechanisms [13-15].

During recent years, research started focusing on projections of future temperature-related health impacts. One of those studies showed a general increase in the net mortality burden by the end of the 21st century with varying results across different regions of the world [16]. Nevertheless, the study demonstrated that in temperate regions like northern Europe, relatively less intense warming and a large decrease in cold-related mortality may result in a net reduction in temperature-related mortality. However, the study did not encompass the risk across differently vulnerable subpopulations. In contrast, another study in the UK concluded that in the absence of any population adaptation, heat-related deaths would increase by around 257% by the 2050s and that the elderly population will experience most of the risk [17]. Most studies on future temperature-related health impacts take mortality into account, while morbidity projections are scarce. Additionally, so far most studies focus on total mortality and do not consider cardiovascular and pulmonary mortality or morbidity outcomes, which may account for most of the temperature-related health effects [18]. Results from a Chinese study show that by the 2080s under the highest climate change scenarios, Representative Concentration Pathway (RCP) 8.5, cardiovascular mortality increases by 134% [18].

Temperature-related health effects are heterogeneous across countries/regions with different climates. Similarly, the population most susceptible to climate change may vary across regions depending on the geographical, demographic and socioeconomic conditions. In a multi-city, multi-community study, stronger associations between heat waves and mortality were observed in moderate cold and moderate warm areas [1]. Neighborhood socioeconomic status, natural environment (e.g. green space, water

bodies), and air conditioning prevalence are among the factors that could explain the spatial heterogeneity in mortality risk associated with heat [19-21]. Beyond the area-level, understanding the individual susceptibility to temperature supports the implementation of targeted interventions to mitigate the adverse health effects. Despite the inconclusive evidence, previous studies suggest larger temperature effects among the elderly and patients with chronic medical conditions, such as cardiovascular disease, diabetes, and neurological disorders [19, 22]. Thus, the need for studies focusing on vulnerable subpopulations and individual effect modifiers is crucial for designing specific adaptation measures to combat the impacts of climate change.

The project EXHAUSTION

The EU-funded project EXHAUSTION aims to address the above discussed research gaps and deliver concrete answers based on a Europe-wide analysis. The project will quantify the future burden of cardiopulmonary disease (CPD) morbidity and mortality attributable to heat and air pollution interplay based upon the exposure-response association from retrospective data and the latest climate modelling techniques, also modelling the socioeconomic cost for CPD. Furthermore, health co-benefits and cost estimates of future adaptation as well as greenhouse gas mitigation actions will be projected.

The Europe-wide analysis will be conducted in three levels (Figure 1). Level 1 analysis will include cities across Europe making use of the Multi-Country Multi-City (MCC) Collaborative Research Network. This will offer a Europe-wide assessment focused on identification of geographical differences across regions, countries and cities, and will assess modifying factors at this geographical scale, such as macro-level demographic and socioeconomic indicators, air pollution, urbanization, health systems, and public health and climate policies. Level 2 analysis will be done in small areas (e.g. municipalities) which will add evidence on temperature and pollution-related health risks with data at higher spatial resolution, including effect modification by factors such as deprivation indices, land-use, urban landscape, housing, and green areas. Level 3 analysis will then add the individual level using data from five established cohorts across Europe with the inspection of individual-level risks and the investigation of vulnerability aspects such as pre-existing health conditions, lifestyle characteristics, physiological parameters, type of dwelling, and social network. To conclude, the project will provide new evidence, based on which stakeholders can design and implement specific adaptation measures to protect the general population and specific vulnerable subgroups.

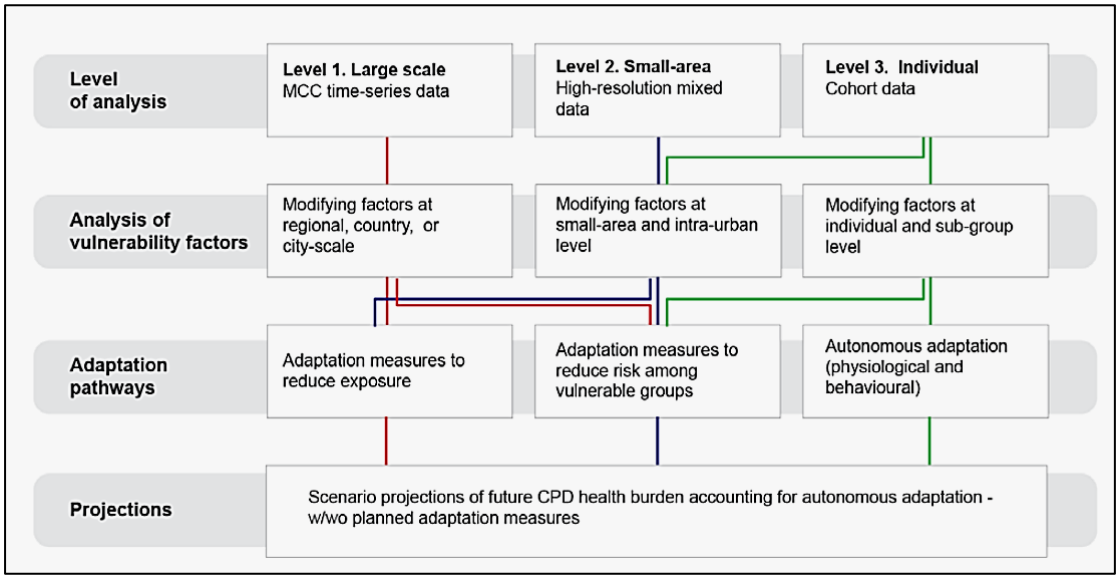

Figure 1: The 3-level approach of EXHAUSTION to study effect modification and reveal adaptive mechanisms at different scales to project attributable cases.

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