Study: An estimated 135 million premature deaths linked to fine particulate matter pollution between 1980 and 2020

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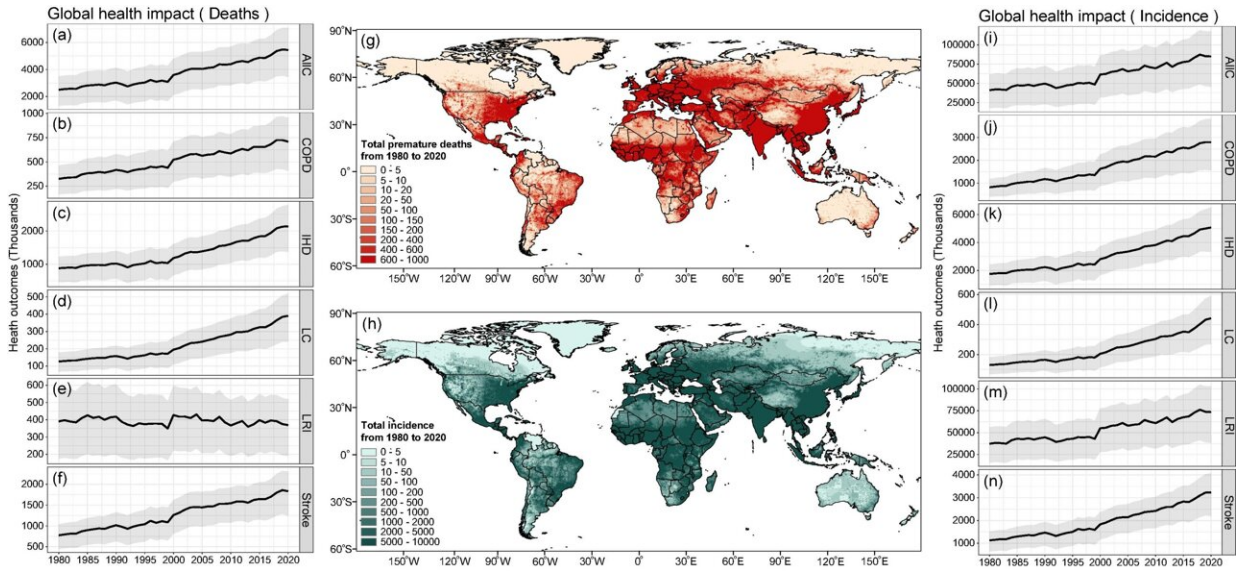

The total $PM_{2.5}$-attributable (a-f and g) premature deaths and (h, i-n) incidence in different countries during 1980–2020. Credit: *Environment International* (2024). DOI: 10.1016/j.envint.2024.108587

A study led by researchers from Nanyang Technological University, Singapore (NTU Singapore) revealed that fine particulate matter from

1980 to 2020 was associated with approximately 135 million premature deaths globally. The findings were published in April in the peer-reviewed journal *Environment International*.

In the study, premature deaths refer to fatalities that occur earlier than expected based on average life expectancy, resulting from preventable or treatable causes such as diseases or environmental factors.

The study found that the impact of pollution from fine particulate matter was worsened by climate variability phenomena such as the El Niño-Southern Oscillation, the Indian Ocean Dipole, and the North Atlantic Oscillation, and led to a 14 percent rise in premature deaths.

The researchers explain that during such weather events, the increased temperature, changes in wind patterns, and reduced precipitation can lead to stagnant air conditions and the accumulation of pollutants in the atmosphere. These result in higher concentrations of $PM_{2.5}$ particles that are particularly harmful to human health when inhaled.

Fine particulate matter, or $PM_{2.5}$, refers to particulate matter 2.5 micrometers in diameter or smaller. These tiny particles come from vehicle emissions, industrial processes, and natural sources such as wildfires and dust storms.

As they are so small, $PM_{2.5}$ particles can easily get into the air we breathe and penetrate deep into our lungs, leading to a range of health problems, especially for vulnerable groups like children, the elderly, and people with respiratory conditions.

The study estimated that a third of the premature deaths from 1980 to 2020 were associated with stroke (33.3%); another third with ischemic

heart disease (32.7%), while chronic obstructive pulmonary disease, lower respiratory infections, and lung cancer made up the rest of premature deaths.

To understand how $PM_{2.5}$ pollution affects mortality rates, the researchers studied satellite data from NASA on the levels of fine particulate matter in the Earth's atmosphere. They also analyzed statistics on the incidence and mortality of diseases linked to pollution from the Institute for Health Metrics and Evaluation, based in the US. Additionally, they considered information on climate patterns from the National Oceanic and Atmospheric Administration.

While previous studies have explored aspects of air quality and climate, this study had a global scope and analyzed over 40 years of data. By examining how specific climate patterns affect air pollution in different regions, it offers fresh insights into the complex relationship between climate and air quality.

First author of the study, Associate Professor Steve Yim of NTU's Asian School of the Environment and Lee Kong Chian School of Medicine (LKCMedicine), who led the study, said, "Our findings show that changes in climate patterns can make air pollution worse. When certain climate events happen, like El Niño, pollution levels can go up, which means more people might die prematurely because of $PM_{2.5}$ pollution.

"This highlights the need to understand and account for these climate patterns when tackling air pollution to protect the health of the global population." Assoc Prof Yim is also a Principal Investigator at NTU's Earth Observatory of Singapore (EOS).

Study co-author Distinguished University Professor Joseph Sung, NTU's Senior Vice President (Health and Life Sciences), and Dean of NTU's LKCMedicine, said, "Our study highlights how climate patterns affect

air pollution, and this is crucial for health care professionals because it directly impacts public health. The effects of climate change and the environment on human health are not lesser than those of genomics and lifestyle patterns, and they have been increasing over the past decades.

"By recognizing these patterns, health care providers can better prepare for potential increases in patients seeking treatment for pollution-related ailments. Additionally, this knowledge underscores the importance of proactive measures to reduce pollution and mitigate its health impacts, ultimately helping health care systems manage and alleviate the burden of pollution-related illnesses on communities."

Assessing the interplay between climate phenomena, pollution, and deaths This study used data from a dataset managed by NASA called MERRA-2 (Modern- Era Retrospective Analysis for Research and Applications, version 2).

The dataset provides monthly information about the concentration of fine particulate matter on the Earth's surface. The $PM_{2.5}$ data analyzed for this 40-year study spans from January 1980 to December 2020 and gives detailed information about air pollution levels in specific areas.

The study looked at how changes in air quality are affected by climate patterns, such as the El Niño-Southern Oscillation, Indian Ocean Dipole, and North Atlantic 4 Oscillation weather patterns, obtained from indices assessed by the US National Oceanic and Atmospheric Administration.

The researchers also used data from the Institute for Health Metrics and Evaluation based in the United States on global deaths and occurrences of pollution-linked diseases, which include lower respiratory infections, tracheal, bronchus, and lung cancer, chronic obstructive pulmonary disease, stroke, and ischemic heart disease.

The researchers found that 363 major air pollution episodes happened worldwide over the past four decades, with an average of nine episodes yearly.

The duration of an air pollution episode ranged from two to nine months, with 2002 being the year with the highest number of air pollution episodes (15 episodes), followed by 2004 and 2006 (14 episodes each year).

The study estimated that Asia had the highest number of premature deaths attributable to $PM_{2.5}$ pollution between 1980 and 2020, at 98.1 million, with China and India reaching 49.0 million and 26.1 million deaths, respectively. Pakistan, Bangladesh, Indonesia, and Japan also had significant numbers of $PM_{2.5}$-attributable premature deaths, ranging from 2 to 5 million each.

The researchers estimate that the three weather phenomena simultaneously caused approximately 7,000 more global premature deaths annually, with the Indian Ocean Dipole phenomena having the largest impact on the number of deaths, followed by North Atlantic Oscillation, and then El Niño.

All three weather patterns coincided in 1994, 1997, 2002, and 2015, with the Southeast Asian region being the most vulnerable. Around 3,100 more deaths occurred in that region each year due to the higher impact of pollution worsened by the weather patterns. Assoc

Prof Yim added, "This study underscores the importance of prioritizing public health when developing air quality strategies. Instead of solely focusing on pollutant levels, governments should also consider the health effects of air pollution. This means evaluating policies based on their impact on reducing pollution-related health issues, especially highlighting the need for targeted interventions to mitigate pollution

during specific weather conditions."

Prof Sung added, "As our study has shown that $PM_{2.5}$ pollution could have significant health consequences, health agencies need to allocate resources accordingly. This includes ensuring that health care services are equipped to handle the demands related to $PM_{2.5}$ pollution-related illnesses. By emphasizing health outcomes in air quality management, governments can better protect public health and improve overall well-being."

The team of researchers will be conducting more detailed studies for a deeper understanding of local air pollution patterns and further detailing the mechanisms behind how climate patterns influence the formation and reduction of $PM_{2.5}$.

More information: S.H.L. Yim et al, Global health impacts of ambient fine particulate pollution associated with climate variability, *Environment International* (2024). DOI: 10.1016/j.envint.2024.108587

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