Potential causal effect of long-term PM_1 exposure on hypertension hospitalization

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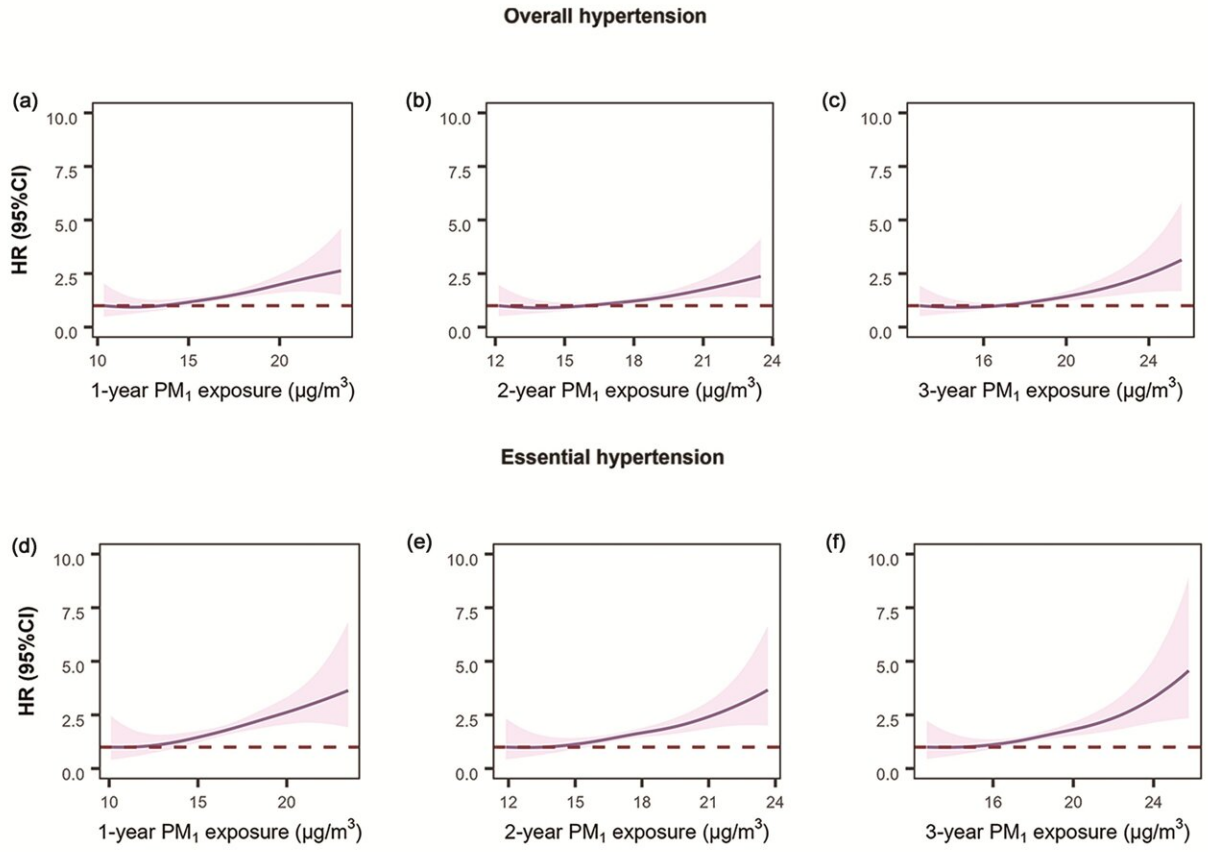

Overall hypertension (a-c) and essential hypertension (d-f) hospitalization risk from 1-year, 2-year, and 3-year PM_1 exposure. Credit: Science China Press

Hypertension is among the leading cardiovascular diseases. Despite

extensive research, evidence concerning the relationship between long-term exposure to ambient particulate matter and hypertension remains limited and inconsistent, particularly with regard to submicron particulate matter (PM_1).

While randomized controlled trials are considered the gold standard for causal inference, environmental epidemiological studies typically rely on observational data. Traditional approaches in observational studies are less effective than randomized controlled trials in fully controlling for confounding factors to achieve results with causal interpretability.

With the advancement of causal analysis methods for observational data, an increasing array of causal inference methods that control for confounding bias are being developed and applied to mimic randomized controlled trials in obtaining effect estimates with causal interpretability.

Led by Yuan-Tao Hao from Peking University, Beijing, China, this study employed marginal structural Cox models utilizing several inverse probability weighting methods to investigate the potential causal effect of hypertension hospitalization from long-term exposure to PM_1 and $PM_{2.5}$, based on the Pearl River cohort in Guangdong, China.

The findings are published in the journal *Science Bulletin*.

Exposure data were obtained from the ChinaHighAirPollutants (CHAP) dataset, provided by Professor Zhan-Qing Li and Dr. Jing Wei from the University of Maryland, which offered high-quality, high-resolution near-surface air pollution data. PM_1 and $PM_{2.5}$ concentration levels were estimated using space-time extremely randomized tree models based on high-resolution satellite data. The study focused on the endpoint of initial hospitalization for both overall hypertension and essential hypertension.

Between January 1 2015 and December 31 2020, a total of 36 thousand adult participants were included in the study, with males comprising 40.6%. The mean age of participants was 50.9 years, with an average of 6.0 years and approximately 210 thousand person-years of follow-up. During the study period, the annual average concentrations of PM_1 and $PM_{2.5}$ were 17.4 μg/m^3 and 33.7 μg/m^3, respectively.

According to the current Chinese "Ambient Air Quality Standards" (GB 3095-2012), the concentration of $PM_{2.5}$ in the study was slightly lower than the annual average concentration standard of 35 μg/m^3 in China However, it significantly exceeds the air quality guidelines (AQG) released by the World Health Organization in 2021, which recommend an annual average concentration of 5 μg/m^3. Due to the limited research, neither international nor Chinese standards for PM_1 concentration have been established.

For every 1 μg/m^3 increase in 1-year PM_1 exposure, the risks of initial hospital admissions due to overall hypertension and essential hypertension increased by 13.1% and 15.3%, respectively. For 2-year PM_1 exposure, the risks of initial hospital admissions due to overall hypertension and essential hypertension increased by 20.7% and 19.0%, respectively.

These findings suggested that the harmful effects of long-term PM_1 exposure persisted for at least 2 years. The risk of hypertension hospitalization associated with long-term PM_1 exposure was 6.0%–11.0% higher compared to $PM_{2.5}$ exposure.

The study revealed a linear exposure-response relationship between PM_1 exposure concentration and the outcome, suggesting that as PM_1 concentration increased, the risk of hypertension hospitalization generally increased monotonically, without a safe threshold.

The study also conducted comprehensive identification of susceptible populations, revealing, for instance, that the risk of hypertension hospitalization in females was 15.3% higher than that in males. The results underscore the importance of controlling PM_1 particulate pollution and protecting vulnerable populations.

This study contributes additional evidence supporting potential causal associations between long-term exposure to PM_1 as well as $PM_{2.5}$ and the risk of hypertension hospitalization. Reducing particle pollution could be beneficial in lowering the risk of hypertension-related hospitalization within 1–2 years. These findings provide valuable scientific insights for the development of future air pollution standards and related public health policies in China.

More information: Yuqin Zhang et al, Long-term PM1 exposure and hypertension hospitalization: A causal inference study on a large community-based cohort in South China, *Science Bulletin* (2024). DOI: 10.1016/j.scib.2024.03.028

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