Short-term exposure to fine particulate matter and mortality: Case-crossover evidence from 32 counties in China

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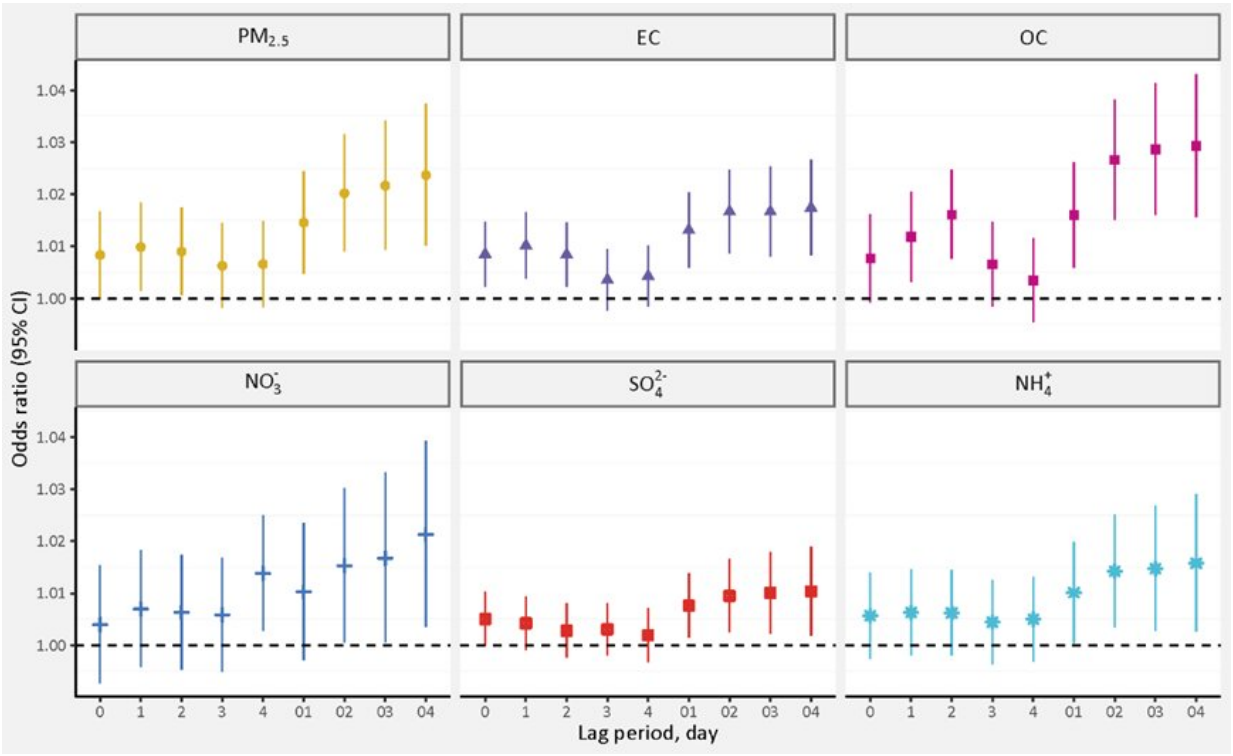

This figure estimates the odds ratios (OR) with 95% confidence intervals (CI) for non-accidental mortality associated with per IQR increase in PM2.5 mass and its constituents across single-day and cumulative lags. Credit: Science China Press

A growing number of studies associate increased mortality with exposures to specific constituents of fine particulate matter ($PM_{2.5}$), while great heterogeneity exists between locations. In China, evidence linking $PM_{2.5}$ constituents and mortality was extensively sparse. This study primarily aimed to quantify short-term associations between $PM_{2.5}$ constituents and non-accidental mortality among the Chinese population. It was led by Dr. Zhang (Department of Epidemiology and Biostatistics, School of Public Health, Wuhan University of Science and Technology).

This study collected daily mortality records from 32 counties in China between January 1, 2011, and December 31, 2013. Daily concentrations of main $PM_{2.5}$ constituents (organic carbon [OC], elemental carbon [EC], nitrate [NO_3^-], sulfate [SO_4^{2-}], and ammonium [NH_4^+]) were estimated using the modified Community Multiscale Air Quality model. Time-stratified case-crossover design with conditional logistic regression models was adopted to assess mortality risks associated with short-term exposures to $PM_{2.5}$ mass and its constituents. Stratification analyses were done by sex, age, and season.

A total of 116,959 non-accidental deaths were investigated. $PM_{2.5}$ concentrations on the day of death were averaged at 75.7 μg/m^3 (control day: 75.6 μg/m^3), with an interquartile range (IQR) of 65.2 μg/m^3. Per IQR rise in $PM_{2.5}$, EC, OC, NO_3^-, SO_4^{2-}, and NH_4^+ at lag-04 day was associated with an increase in non-accidental mortality of 2.4% (95% confidence interval, 1.0–3.7), 1.7% (0.8–2.7), 2.9% (1.6–4.3), 2.1% (0.4–3.9), 1.0% (0.2–1.9), and 1.6% (0.3–2.9), respectively. Both $PM_{2.5}$ mass and its constituents were strongly associated with elevated cardiovascular mortality risks, but only $PM_{2.5}$, EC, and OC were positively associated with respiratory mortality at lag-3 day. $PM_{2.5}$ mass and its constituents' associated effects on mortality varied among sex- and age-specific subpopulations. Differences in the seasonal pattern of associations exist among $PM_{2.5}$ constituents, with stronger effects related to EC and NO_3^- in warm months but SO_4^{2-} and NH_4^+ in cold months.

This study suggested that short-term exposures to $PM_{2.5}$ compositions were positively associated with increased risks of mortality, particularly those constituents from combustion-related sources. In conclusion, this study contributes to an in-depth understanding of the acute health effects of short-term exposure to $PM_{2.5}$ and its constituents in moderate to severe pollution scenarios. It provides essential evidence support for a comprehensive assessment of the death burden caused by particulate matter constituents.

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