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Short term exposure to fine particulate matter and hospital admission risks and costs in the Medicare population: time stratified, case crossover study

Yaguang Wei,¹ Yan Wang,^{1,2} Qian Di,³ Christine Choirat,⁴ Yun Wang,² Petros Koutrakis,¹ Antonella Zanobetti,¹ Francesca Dominici,² Joel D Schwartz¹

¹Department of Environmental Health, Harvard T H Chan School of Public Health, Boston, MA, USA

²Department of Biostatistics, Harvard T H Chan School of Public Health, Boston, MA 02115, USA

³Research Center for Public Health, School of Medicine, Tsinghua University, Beijing, China

⁴Swiss Data Science Centre (ETH Zürich and EPFL), Zürich, Switzerland

Correspondence to: F Dominici (fdominic@hsph.harvard.edu (or @francescadominici on Twitter; ORCID 0000-0002-9382-0141)

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ABSTRACT OBJECTIVE

To assess risks and costs of hospital admission associated with short term exposure to fine particulate matter with diameter less than 2.5 μm ($\text{PM}_{2.5}$) for 214 mutually exclusive disease groups.

DESIGN

Time stratified, case crossover analyses with conditional logistic regressions adjusted for non-linear confounding effects of meteorological variables.

SETTING

Medicare inpatient hospital claims in the United States, 2000–12 (n=95 277 169).

PARTICIPANTS

All Medicare fee-for-service beneficiaries aged 65 or older admitted to hospital.

MAIN OUTCOME MEASURES

Risk of hospital admission, number of admissions, days in hospital, inpatient and post-acute care costs, and value of statistical life (that is, the economic value used to measure the cost of avoiding a death) due to the lives lost at discharge for 214 disease groups.

RESULTS

Positive associations between short term exposure to $\text{PM}_{2.5}$ and risk of hospital admission were found for several prevalent but rarely studied diseases, such as septicemia, fluid and electrolyte disorders,

and acute and unspecified renal failure. Positive associations were also found between risk of hospital admission and cardiovascular and respiratory diseases, Parkinson's disease, diabetes, phlebitis, thrombophlebitis, and thromboembolism, confirming previously published results. These associations remained consistent when restricted to days with a daily $\text{PM}_{2.5}$ concentration below the WHO air quality guideline for the 24 hour average exposure to $\text{PM}_{2.5}$. For the rarely studied diseases, each 1 $\mu\text{g}/\text{m}^3$ increase in short term $\text{PM}_{2.5}$ was associated with an annual increase of 2050 hospital admissions (95% confidence interval 1914 to 2187 admissions), 12 216 days in hospital (11 358 to 13 075), US\$31m (£24m, €28m; \$29m to \$34m) in inpatient and post-acute care costs, and \$2.5bn (\$2.0bn to \$2.9bn) in value of statistical life. For diseases with a previously known association, each 1 $\mu\text{g}/\text{m}^3$ increase in short term exposure to $\text{PM}_{2.5}$ was associated with an annual increase of 3642 hospital admissions (3434 to 3851), 20 098 days in hospital (18 950 to 21 247), \$69m (\$65m to \$73m) in inpatient and post-acute care costs, and \$4.1bn (\$3.5bn to \$4.7bn) in value of statistical life.

CONCLUSIONS

New causes and previously identified causes of hospital admission associated with short term exposure to $\text{PM}_{2.5}$ were found. These associations remained even at a daily $\text{PM}_{2.5}$ concentration below the WHO 24 hour guideline. Substantial economic costs were linked to a small increase in short term $\text{PM}_{2.5}$.

WHAT IS ALREADY KNOWN ON THIS TOPIC

Short term exposure to $\text{PM}_{2.5}$ is associated with increased risk of mortality and hospital admissions due to cardiovascular and respiratory diseases, diabetes mellitus, neurological diseases, and deep vein thrombosis, among others. Existing evidence for the health effects of short term exposure to $\text{PM}_{2.5}$ was driven by hypotheses about specific disease outcomes that might be affected by the exposure, which could underestimate the potential effects of exposure to $\text{PM}_{2.5}$ if other diseases are not negligible.

WHAT THIS STUDY ADDS

Short term exposure to $\text{PM}_{2.5}$ was positively associated with risks of several prevalent but rarely studied causes of hospital admissions, such as septicemia, fluid and electrolyte disorders, acute and unspecified renal failure, and intestinal obstruction without hernia.

When the analysis was restricted to days with a daily $\text{PM}_{2.5}$ concentration below the WHO air quality guideline for the 24 hour average exposure to $\text{PM}_{2.5}$, most newly identified causes of hospital admission and those identified from previously published studies remained positively associated with short term $\text{PM}_{2.5}$ exposure, suggesting that the guideline needs updating.

A small increase in short term $\text{PM}_{2.5}$ was associated with substantial inpatient and post-acute care costs and the economic costs due to lives lost at discharge.