Air pollution impacts

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Health risks of exposure to wildfire-toxic air

Yiwen Zhang, Rongbin Xu, Wenzhong Huang, Tingting Ye, Pei Yu, Wenhua Yu, Yao Wu, Yanming Liu, Zhengyu Yang, Bo Wen, Ke Ju, Jiangning Song, Michael J. Abramson, Amanda Johnson, Anthony Capon, Bin Jalaludin, Donna Green, Eric Lavigne, Fay H. Johnston, Geoffrey G. Morgan, Luke D. Knibbs, Ying Zhang, Guy Marks, Jane Heyworth, Julie Arblaster, Yue Leon Guo, Lidia Morawska, Micheline S. Z. S. Coelho, Paulo H. N. Saldiva, Patricia Matus, Peng Bi, Simon Hales, Wenbiao Hu, Dung Phung, Yuming Guo & Shanshan Li

Evaluating the short-term exposure to wildfire-specific fine particulate matter ($PM_{2.5}$) showed greater risks of hospitalization for all major respiratory diseases than non-wildfire $PM_{2.5}$. When developing air quality guidelines, it is also important to consider that $PM_{2.5}$ from varying sources can have different health effects, which require targeted health and environmental policy approaches.

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The policy problem

Wildfire-specific air pollution is an increasing public health concern under a warming climate with a greater frequency and intensity of wildfire occurrences. Previous estimates reveal that fire-prone regions globally might increase by 29% by 2100. Given the socioeconomic and health burdens expected from wildfire-specific air pollution and limited research in this area, it becomes necessary to evaluate the respiratory hospitalization risk from such pollution sources and identify vulnerable populations at a higher risk of wildfire-specific $PM_{2.5}$ exposure. This is important for the development of targeted relief efforts and evidence-based mitigation and adaptation strategies, in addition to air quality policies that account for the varying health impacts of $PM_{2.5}$ that differ by emission sources.

The findings

We found that wildfire-specific $PM_{2.5}$ emerged as a significant source of respiratory hospitalization risks from short-term $PM_{2.5}$ exposure. It posed a greater risk for all major types of respiratory diseases than non-wildfire $PM_{2.5}$ (Fig. 1). Annually, around 25,321 respiratory hospitalizations were attributable to wildfire-specific $PM_{2.5}$, with its proportion relative to total respiratory hospitalizations increasing in Australia, Vietnam and Taiwan during 2000–2019. Wildfire's substantial contribution to $PM_{2.5}$-linked respiratory hospitalizations demands continued relief efforts across most countries and territories. Vulnerable disease types and populations needing targeted intervention were influenza, children and adolescents, older individuals, individuals in low-income and high-polluted communities, and residents of Brazil, Thailand, Taiwan and Vietnam. Our findings can be generalized to regions sharing similar socio-demographic characteristics with our study communities. Despite extensive spatiotemporal coverage, this study cannot be interpreted as a global representative because it only included seven countries and territories with the best data availability.

The study

We performed a time-series analysis on 35.6 million daily respiratory hospitalization counts across 1,052 communities in Australia, Brazil, Canada, Chile, New Zealand, Vietnam, Thailand and Taiwan, during varying periods in 2000–2019. The statistical method included two stages, which works perfectly for multi-location data in epidemiology. In stage one, we estimated the respiratory hospitalization risk associated with wildfire-specific $PM_{2.5}$ in each community separately. In stage two, we combined the risk estimates from different communities to calculate the overall risk, along with the risk for different population groups and each country and territory. Using the same method, we also estimated the hospitalization risk for respiratory diseases from exposure to non-wildfire $PM_{2.5}$. We further calculated the respiratory hospitalizations attributable to $PM_{2.5}$ from both wildfire and non-wildlife sources. Our large dataset and the unified well-established two-stage analytic framework facilitate robust, generalizable and comparable findings.

Messages for policy

- Wildfires emerged as a source of significant concern for adverse respiratory health from exposure to $PM_{2.5}$, exhibiting higher toxicity than $PM_{2.5}$ from other sources.
- Targeted relief efforts should be prioritized for influenza, children and adolescents, older individuals, and populations in low-income or high-polluted communities.
- Raising awareness of wildfire air pollution health risks, improving emission control, monitoring wildfire air pollution levels and strengthening community preparedness serve as potential solutions.

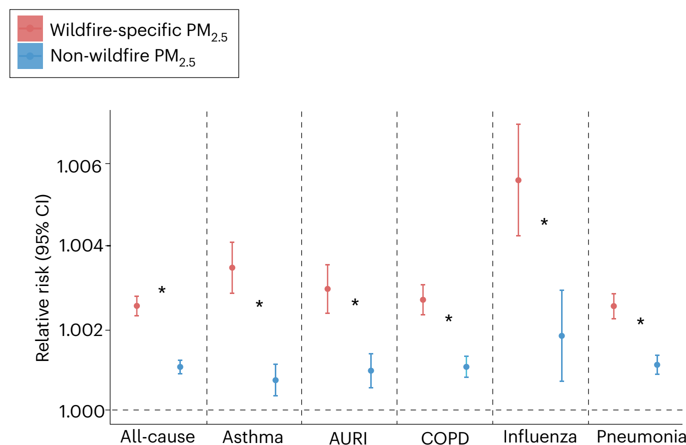

Fig. 1 | The impacts of wildfire-specific $PM_{2.5}$ on respiratory hospitalization. The relative risks (per 1 μg m^{-3}) of hospitalizations for cause-specific respiratory disease associated with wildfire-specific and non-wildfire $PM_{2.5}$. *$P < 0.05$. AURI, acute upper respiratory infection; CI, confidence interval; COPD, chronic obstructive pulmonary disease.

Yiwen Zhang[1], Rongbin Xu[1], Wenzhong Huang[1], Tingting Ye[1], Pei Yu[1], Wenhua Yu[1], Yao Wu[1], Yanming Liu[1], Zhengyu Yang[1], Bo Wen[1], Ke Ju[1], Jiangning Song[2], Michael J. Abramson[3], Amanda Johnson[1], Anthony Capon[3], Bin Jalaludin[4], Donna Green[5], Eric Lavigne[6,7], Fay H. Johnston[8], Geoffrey G. Morgan[9], Luke D. Knibbs[9,10], Ying Zhang[9], Guy Marks[11], Jane Heyworth[12], Julie Arblaster[13], Yue Leon Guo[14], Lidia Morawska[15], Micheline S. Z. S. Coelho[16], Paulo H. N. Saldiva[16], Patricia Matus[17], Peng Bi[18], Simon Hales[19], Wenbiao Hu[20], Dung Phung[21], Yuming Guo[1,22] & Shanshan Li[1,22] ✉

[1]Climate, Air Quality Research Unit, School of Public Health and Preventive Medicine, Monash University, Melbourne, Victoria, Australia. [2]Monash Biomedicine Discovery Institute, Department of Biochemistry and Molecular Biology, Monash University, Melbourne, Victoria, Australia. [3]School of Public Health and Preventive Medicine, Monash University, Melbourne, Victoria, Australia. [4]School of Population Health, the University of New South Wales, Sydney, New South Wales, Australia. [5]School of Biological, Earth & Environmental Sciences, the University of New South Wales, Sydney, New South Wales, Australia. [6]School of Epidemiology and Public Health, University of Ottawa, Ottawa, Ontario, Canada. [7]Environmental Health Science and Research Bureau, Health Canada, Ottawa, Ontario, Canada. [8]Menzies Institute for Medical Research, University of Tasmania, Hobart, Tasmania, Australia. [9]Sydney School of Public Health, The University of Sydney, Sydney, New South Wales, Australia. [10]Public Health Research Analytics and Methods for Evidence, Public Health Unit, Sydney Local Health District, Camperdown, New South Wales, Australia. [11]School of Clinical Medicine, University of New South Wales, Sydney, New South Wales, Australia. [12]Faculty of Health and Medical Sciences, University of Western Australia, Crawley, Western Australia, Australia. [13]School of Earth, Atmosphere and Environment, Monash University, Melbourne, Victoria, Australia. [14]Environmental and Occupational Medicine, National Taiwan University and National Taiwan University Hospital, Taipei, Taiwan. [15]School of Earth and Atmospheric Sciences, Queensland University of Technology, Brisbane, Queensland, Australia. [16]Department of Pathology, School of Medicine, University of São Paulo, São Paulo, Brazil. [17]School of Medicine, University of the Andes (Chile), Las Condes, Chile. [18]School of Public Health, The University of Adelaide, Adelaide, South Australia, Australia. [19]Department of Public Health, University of Otago, Wellington, New Zealand. [20]School of Public Health & Social Work, Queensland University of Technology, Brisbane, Queensland, Australia. [21]School of Public Health, University of Queensland, Brisbane, Queensland, Australia. [22]These authors jointly supervised this work: Yuming Guo, Shanshan Li.
✉e-mail: shanshan.li@monash.edu

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Further reading

1. Xu, R. et al. Wildfires, global climate change, and human health. *N. Engl. J. Med.* **383**, 2173–2181 (2020).
   This special report outlines the human health risks posed by wildfires under climate change and offers practical steps that individuals can take to mitigate exposure to wildfire smoke and its associated health risks.
2. Xu, R. et al. Global population exposure to landscape fire air pollution from 2000 to 2019. *Nature* **621**, 521–529 (2023).
   This global study reveals that billions of people worldwide were exposed to significant levels of landscape fire air pollution, with particularly high exposure in regions such as Central Africa, Southeast Asia, South America, Siberia and the least developed countries.
3. Xu, R. et al. Global, regional, and national mortality burden attributable to air pollution from landscape fires: a health impact assessment study. *Lancet* **404**, 2447–2459 (2024).
   This health assessment study highlights a significant global mortality burden attributable to landscape fire air pollution, with notable disparities across geographical regions and socioeconomic levels.
4. Aguilera, R., Corringham, T., Gershunov, A. & Benmarhnia, T. Wildfire smoke impacts respiratory health more than fine particles from other sources: observational evidence from Southern California. *Nat. Commun.* **12**, 1493 (2021).
   This observational study finds a stronger association between wildfire-specific $PM_{2.5}$ exposure and respiratory hospitalizations in southern California (1999–2012) compared with non-wildfire $PM_{2.5}$ exposure.

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Competing interests

The authors declare no competing interests.