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Commentary

Health-oriented strategies are needed to optimize China's 2025 clean air action plan

Tao Xue [a,b,c,1,*], Ning Kang [a,1], Wei Wan [d], Tong Zhu [b,e,*]

[a] Institute of Reproductive and Child Health/National Health Commission Key Laboratory of Reproductive Health and Department of Epidemiology and Biostatistics/Ministry of Education Key Laboratory of Epidemiology of Major Diseases (PKU), School of Public Health, Peking University Health Science Centre, Beijing 100191, China
[b] State Environmental Protection Key Laboratory of Atmospheric Exposure and Health Risk Management, Center for Environment and Health, Peking University, Beijing 100871, China
[c] Advanced Institute of Information Technology, Peking University, Hangzhou 311215, China
[d] Clean Air Asia, Beijing 100600, China
[e] College of Environmental Sciences and Engineering, Peking University, Beijing 100871, China

Recently, China's State Council issued the *Continuous Improvement of Air Quality Action Plan* (hereafter, the third action plan), which follows the *Air Pollution Prevention and Control Action Plan* (2013–2017) (hereafter, the first action plan) and the *Three-Year Action Plan for Winning the Blue Sky Defense Battle* (2018–2020) (hereafter the second action plan). The first two action plans yielded nationwide health benefits [1–3], from improving lung function [4] to saving medical expenditures [5]. Based on our previous estimates [6], due to reductions in the fine particulate matter ($PM_{2.5}$) level, implementation of the first and second action plans was expected to increase life expectancy by 2.11 and 3.68 months, respectively. A major aim of the third action plan is to continuously improve health, with many action items related to $PM_{2.5}$ that could induce greater changes compared with the previous plans. For instance, this plan is the first to include the goal that all cities reduce their $PM_{2.5}$ concentration by at least 10% by 2025 compared with the 2020 concentration. Moreover, more cities are categorized as key $PM_{2.5}$ control regions, which have more stringent goals; the Beijing-Tianjin-Hebei and surrounding area includes 10 additional cities, which have the goal of reducing the $PM_{2.5}$ concentration by 20%. Other goals include reducing the $PM_{2.5}$ concentration by 15% in Fenwei Plain, to <32 μg m^{-3} in Beijing, and to <35 μg m^{-3} in the Yangtze River Delta. However, climate change and an aging population pose new challenges to reducing the burden of air pollution [7,8].

To evaluate the outcomes of achieving $PM_{2.5}$ reduction goals in the third action plan, we calculated the $PM_{2.5}$ attributable loss of life expectancy, which was previously developed to quantify the health impacts from the first and second action plans [6]. Assuming the third action plan goals will be achieved by 2025 and population characteristics remain the same as in 2020, the population-weighted mean $PM_{2.5}$ concentration would be 30.9 μg m^{-3}. The decreases in average $PM_{2.5}$ exposure level resulting from the first, second, and third action plans are 21.8, 11.3, and 4.8 μg m^{-3}, respectively (Fig. 1a). In the 2025 scenario, $PM_{2.5}$ exposure contributes to 927 premature deaths per 1 million adults, accounting for a loss of life expectancy at birth of 1.27 years. The first, second, and third action plans were predicted to reduce the $PM_{2.5}$-related loss of life expectancy by 2.1, 3.7, and 1.5 months, respectively (Fig. 1b). Among them, the second plan, which maintains the rapid trend in $PM_{2.5}$ concentration reduction observed since 2013, is optimal for public health, as the sublinear relationship between $PM_{2.5}$ and mortality leads to a larger health benefit from an air quality improvement at a lower concentrations, as demonstrated by previous research [6]. Additionally, annual rates of change (Fig. 1c) at both the national and regional scales show that the improvement resulting from the 2025 action plan will slow, with health improvement showing a smaller reduction than air quality improvement.

The rate of air quality improvement decreases in the later stages of clean air action plans, a trend observed worldwide. To efficiently prevent diseases caused by air pollution, a health-oriented strategy is needed to optimize relevant polices. First, air quality standards, the cornerstone to protecting human health, should be improved in China. China's annual $PM_{2.5}$ standard of 35 μg m^{-3} offers less protection than the 5 μg m^{-3} level recommended by the World Health Organization. Under the third action plan, the Chinese standard will have been met for two out of every three people by 2025 (66.8% of the population); thus, the current standard should be lowered. The third action plan has the goal of initializing the revision of national ambient air quality standards by 2025, which will expand the capacity for further health improvements beyond those conferred by current $PM_{2.5}$ targets.

In addition, air quality goals should be coordinated with climate goals to promote health improvements via multiple pathways, such as the coordinated benefits of emission reductions and the interactions between climate and aerosols. For instance, an ambitious air pollution control goal in China would reduce the $PM_{2.5}$ concentration to 30 μg m^{-3} by 2030; incorporating mitigations to achieve the 1.5 °C climate change goal would further reduce the concentration to 20 μg m^{-3} [9]. Furthermore, the recent 2023 United Nations Climate Change Conference or Conference of the

* Corresponding authors.
E-mail addresses: txue@hsc.pku.edu.cn (T. Xue), tzhu@pku.edu.cn (T. Zhu).
[1] These authors contributed equally to this work.

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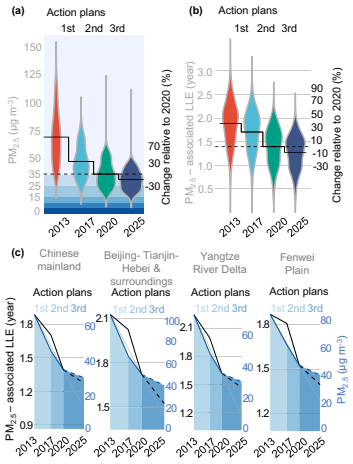

Fig. 1. (a) Changes in $PM_{2.5}$ exposure resulting from the first, second, and third air quality action plans in China. (b) Loss of life expectancy (LLE) resulting from health benefits associated with per-unit reductions in the $PM_{2.5}$ concentration. (c) Trends in air quality and health improvements resulting from air pollution controls in Chinese mainland and key regions. Black lines denote $PM_{2.5}$-associated loss of life expectancy, and the blue lines denote $PM_{2.5}$ concentration; dashed lines denote results of the third action plan; gray lines denote the average trends across the first and second action plans.

Parties of the UNFCCC (i.e., COP28) launched an official health day for the first time to recognize health as the core objective in coordinating climate actions.

Finally, adaptions to enhance air pollution resilience will amplify the health benefits of realizing clean air goals. Recent investigations have shown interindividual differences in the susceptibility to the adverse effects of air pollution. According to the United States Environmental Protection Agency [10], adequate evidence demonstrates that children are more susceptible to $PM_{2.5}$ than adults; additional data suggest enhanced individual susceptibility due to underlying chronic diseases (e.g., cardiovascular and respiratory diseases), unhealthy behaviors (e.g., obesity and smoking), and genetic mutations. Interventions targeting susceptibility modifiers may improve human adaptations to air pollution, thereby reducing the burden of diseases. For example, the *Healthy China* plan aims to reduce the rate of chronic diseases by 30% from 2015 to 2030, making future populations more resilient to the adverse health effects of air pollution.

In conclusion, for continuous improvement of air quality and human wellbeing, a health-oriented decision system that simultaneously informs clean air actions, climate mitigation efforts, and chronic and infectious disease prevention is warranted.

Conflict of interest

The authors declare that they have no conflict of interest.

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Tao Xue is an assistant professor at School of Public Health, Peking University Health Science Centre. His research interest mainly focuses on effects of air pollution, and health risk assessment based on multi-source data.

Ning Kang is a currently Ph.D. student supervised by Dr. Tao Xue and Dr. Tong Zhu at the School of Public Health, Peking University Health Science Centre. He earned a M.S. degree from Zhengzhou University. His thesis research focuses on climate change, environmental exposure assessment, and attributable burden of diseases.

Tong Zhu is a professor at the College of Environmental Sciences and Engineering at Peking University, an academician of the Chinese Academy of Sciences, a counselor of the State Council, and a fellow of the American Geophysical Union. He has been committed to pioneering scientific research in atmospheric chemistry, human exposure, and health.