World Health Organization air quality guidelines 2021: implication for air pollution control and climate goal in China

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Air pollution is one of the biggest environmental threats to human health. In 2005, the World Health Organization (WHO) released its first global air quality guidelines (AQGs) for particulate matter (PM), ozone (O_3), nitrogen dioxide (NO_2), and sulfur dioxide.[1] On September 22, 2021, the WHO updated its AQGs, providing clear evidence of the adverse health effects of air pollution, at even lower concentrations than previously understood.[2] For instance, the WHO AQGs 2021 recommend annual mean concentrations of $PM_{2.5}$ not exceeding 5 $\mu g/m^3$ and NO_2 not exceeding 10 $\mu g/m^3$ and the peak season mean 8-h O_3 concentration not exceeding 60 μg/m.[2,3] As a comparison, the corresponding WHO AQGs 2005 values were 10 $\mu g/m^3$ for $PM_{2.5}$ and 40 $\mu g/m^3$ for NO_2, with no recommendation for long-term O_3 concentrations.[1]

The WHO AQGs 2021 generally reflect an overwhelming body of evidence showing that the adverse effects of air pollution can be observed not only at high exposures but also at very low concentration levels. As an example, a global study of 652 cities in 24 countries found significant effect of $PM_{2.5}$ on daily death risk at levels below most global and regional AQGs or standards.[3] For this update, the WHO used an innovative approach, the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) framework, to make recommendations for AQGs. Previously, GRADE has been developed to standardize the approach to judging the certainty of the effects of clinical interventions. While widely used in clinical medicine, its application in environmental health sciences is challenging. After a systematic review of the latest evidence and meta-analyses of quantitative effect estimates to inform updating of the AQG levels, the guideline values are recommended based on the lowest levels of exposure for which there is evidence of adverse health effects.

Air pollution is a threat to human health in all countries, but its impact in the low- and middle-income countries are the greatest. As the largest developing country, China has been changing rapidly over the past four decades and its economic expansion is largely driven by the use of fossil fuels, leading to a dramatic increase in emissions of both air pollutants and greenhouse gases.[4] Because of the same origin of air pollution and climate change, any continuous air quality improvement actions will help low-carbon development, and vice versa. Air pollution and climate change are now among the top risk factors for mortality and morbidity of Chinese population. The global burden of disease study estimated that air pollution and non-optimal temperature contributed to over 1.8 and 0.6 million deaths, respectively, in 2019 in China.[5]

As the WHO pointed out, the AQGs are not legally binding; however, it can provide reference for decision makers in various countries, including China, to guide legislation, policies, and plans to control air pollution and to reduce the health burden of air pollution. For example, the "Ambient Air Quality Standards" (AQSs) issued by China in 2012 referred to the WHO AQGs 2005. The current $PM_{2.5}$ standard in China (Class 2) actually corresponds to the interim target 1 in WHO AQGs 2021 and 2005 [Table 1]. This was an active attempt by the Chinese government to integrate with international guidelines in environmental governance.

After China's AQS included $PM_{2.5}$ for the first time in 2012, the Chinese government implemented the Air

Access this article online

Quick Response Code:

Website: www.cmj.org

DOI: 10.1097/CM9.0000000000002014

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Chinese Medical Journal 2022;135(5)

Received: 08-10-2021; **Online:** 10-02-2022 **Edited by:** Jing Ni

Table 1: A comparison between China Air Quality Standard (AQS, GB3095-2012) and WHO AQG 2021.

Parameters	China AQS* (GB3095-2012)		WHO AQG 2021				
	Class 1	Class 2	AQG	IT 1	IT 2	IT 3	IT 4
$PM_{2.5}$ (μg/m^3)							
Annual	15	35	5	35	25	15	10
24-h	35	75	15	75	50	37.5	25
PM_{10} (μg/m^3)							
Annual	40	70	15	70	50	30	20
24-h	50	150	45	150	100	75	50
O_3 (μg/m^3)							
Peak season	–	–	60	100	70	–	–
8-h	100	160	100	160	120	–	–
1-h	160	200	–	–	–	–	–
NO_2 (μg/m^3)							
Annual	40	40	10	40	30	20	–
24-h	80	80	25	120	50	–	–
1-h	200	200	–	–	–	–	–
SO_2 (μg/m^3)							
Annual	20	60	–	–	–	–	–
24-h	50	150	40	125	50	–	–
1-h	150	500	–	–	–	–	–
CO (mg/m^3)							
24-h	4	4	4	7	–	–	–
1-h	10	10	–	–	–	–	–

* Class 1 standard applies to special regions (including national parks) and Class 2 applies to all other areas. AQG: Air quality guidelines; AQS: Ambient Air Quality Standards; IT: Interim target; PM: Particulate matter; WHO: World Health Organization.

Pollution Prevention and Control Action Plan (APPCAP) from 2013 to 2017, requiring that by 2017, the concentration of $PM_{2.5}$ in the Beijing-Tianjin-Hebei, Yangtze River Delta, and Pearl River Delta regions would decrease by 25%, 20%, and 15%, respectively. Following APPCAP, the Chinese government implemented the Three-Year Action Plan for Winning the Blue Sky Defense War from 2018 to 2020, requiring that by 2020 the concentration of $PM_{2.5}$ should be reduced by >18% from 2015 nationally. As the consequence of these two Action Plans, the average annual concentration of $PM_{2.5}$ in 337 Chinese cities was 33 μg/m^3 in 2020, which was lower than the annual China AQS (Class 2) for the first time. With the continuous improvement of China's air quality since 2013, the current AQS no longer has a strong leading role for most Chinese cities that have reached the standards. Leading cities represented by Shenzhen have already taken the lead in setting more ambitious air quality management goals. The Ministry of Ecology and Environment (MEE) stated that the air quality concentration improvement target during the 14th Five-Year Plan period is considered to be set to reduce the average concentration of $PM_{2.5}$ by 10%. In China, it is the MEE's responsibility to update the AQS regularly. Whether and when to start a new round of standard revisions has been put on the MEE's agenda. The release of the WHO AQG 2021 will inevitably trigger more discussions. More in-depth research and discussion will be needed to make balance between the ideal target value and the practical feasibility in China.

China now is the largest emitter of carbon dioxide.[6] In September 2020, China announced its ambitious climate commitment to achieve carbon peak by 2030 and carbon neutrality by 2060, providing a huge driving force for the continuous improvement of China's air quality.[7] Reaching the level of the WHO AQGs may depend upon the air quality co-benefits of ambitious climate actions. Cheng et al estimated that if China achieves carbon neutrality in 2060, the average annual $PM_{2.5}$ exposure level will reach 8 μg/m^3, much lower than the current China AQS but slightly higher than the WHO AQGs 2021.[7]

Conclusively, the WHO AQGs 2021 are based on a comprehensive assessment of scientific evidence on air pollution health effects and are not legally binding. Transforming the WHO AQGs into China's legally effective AQS requires a complicated analysis of society, economy, technology, and other aspects. In the future, it is necessary to provide localized research findings to decision-makers for the revision of China's AQS. Clinicians, environmental and public health scientists can also use the WHO AQG as a tool to drive and support the selection and adoption of measures to reduce exposure to air pollution, strengthen multi-sectoral cooperation, advocate for air quality and climate action, and take effective steps to reduce health inequities related to air pollution. Finally, air quality, climate change, and public health should be taken into account simultaneously. China's carbon neutrality goals will play a critical role in reducing air pollution exposure to the level of the WHO AQGs and protecting public health. Consideration of the health impacts of air pollution and climate change can help the government move forward towards sustainable development with appropriate urgency.

Funding

This work was supported by grants from the National Natural Science Foundation of China (Nos. 92043301, 91843302, and 82030103) and the Fifth Round of the Three-Year Public Health Action Plan of Shanghai (No. GWV-10.1-XK11).

Conflicts of interest

None.

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How to cite this article: Kan H. World Health Organization air quality guidelines 2021: implication for air pollution control and climate goal in China. Chin Med J 2022;135:513–515. doi: 10.1097/CM9.0000000000002014