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Perspective

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Clearing the Air: a Global Health Perspective on Air Pollution

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Abstract

Air pollution is responsible for one in eight deaths globally per year. The severity of air pollution and its effects on global health are frequently discussed in the literature but are poorly reflected in health policy and have not yet resulted in sufficient actionable change. Air pollution mitigation policies should embody the planetary health concept, which highlights the interdependence between the health of humans and the planet. There is an urgent need for the standardisation of air quality measurement and programmes on a global scale. A reduction in fine particulate matter has been shown to contribute to the greatest degree of public health benefits. Current efforts to improve urban air quality include a significant focus on the transition to sustainable energy and transportation through the electrification of transportation. There are two main fronts in the campaign against pollution, one being the reduction of anthropogenic emissions through public and government policy, and the other being the introduction of novel attempts to decrease pollution and other innovative research to develop new approaches that will ultimately improve global health.

Keywords: Climate Change, Air Pollutants, Global Health, Health Inequities

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Introduction

Air pollution is responsible for one in eight deaths globally per year.[1] Worldwide, the average person is exposed to over three-fold the World Health Organization's (WHO's) particulate matter (PM) guideline threshold of 10 μg/m^3.[1,2] The effect of air pollution on life expectancy is 114-fold that of conflict and terrorism, three-fold that of substance abuse and unsafe water access, and five-fold that of HIV/AIDS, making it a leading risk factor for premature mortality.[2,3] Decreasing air pollution to WHO guidelines would add 2.2 years onto global life expectancy. In Nigeria, this is increased to 4.3 years, and up to 6 years in India and Bangladesh.[2] These countries all rank in the top 10 most polluted and populated countries worldwide and bear the greatest burden of air pollution, accounting for 60% of the person-years to be lost if the trajectory of air pollution continues to escalate.[2] Over 94% of the population of Central and West Africa and 50% of the people of Latin America breathe polluted air due to increased traffic congestion and high use of household fuels.[2] In contrast, through strict policy implementation, China, Europe, Japan, and North America now account for only 2% of the global health burden from air pollution.[2] Air pollution has traditionally been a neglected subject in leading travel medicine and global health journals,[3,4] although a greater focus has recently emerged in the travel medicine literature.[5-7] This perspective article approaches air pollution using a global health lens and challenges the medical community to become champions of environmental sustainability.

Sources and Health Effects of Air Pollution

PM is composed of solid particles or liquid matter of organic and inorganic substances that float in air. The main constituents of particulate pollution contributing to diminished air quality and health include a mixture of black carbon (soot), heavy metals, sulphates, nitrates, and ammonium.[2,8] Most importantly, it is the microscopic size of PM that dictates where it deposits in the body via the gastrointestinal and respiratory systems. PM_{10} can lodge inside the lungs, while $PM_{2.5}$ is small enough to penetrate the alveoli and disseminate into the bloodstream to produce inflammation, oxidative damage, and vascular dysfunction resulting in non-communicable diseases of the cardiovascular, respiratory, and nervous systems (Figure 1).[2,8-11] Burning of fossil fuels is the primary anthropogenic contributor to particulate pollution and accounts for 60% of urban ambient $PM_{2.5}$, while biomass burning, where crop and residential

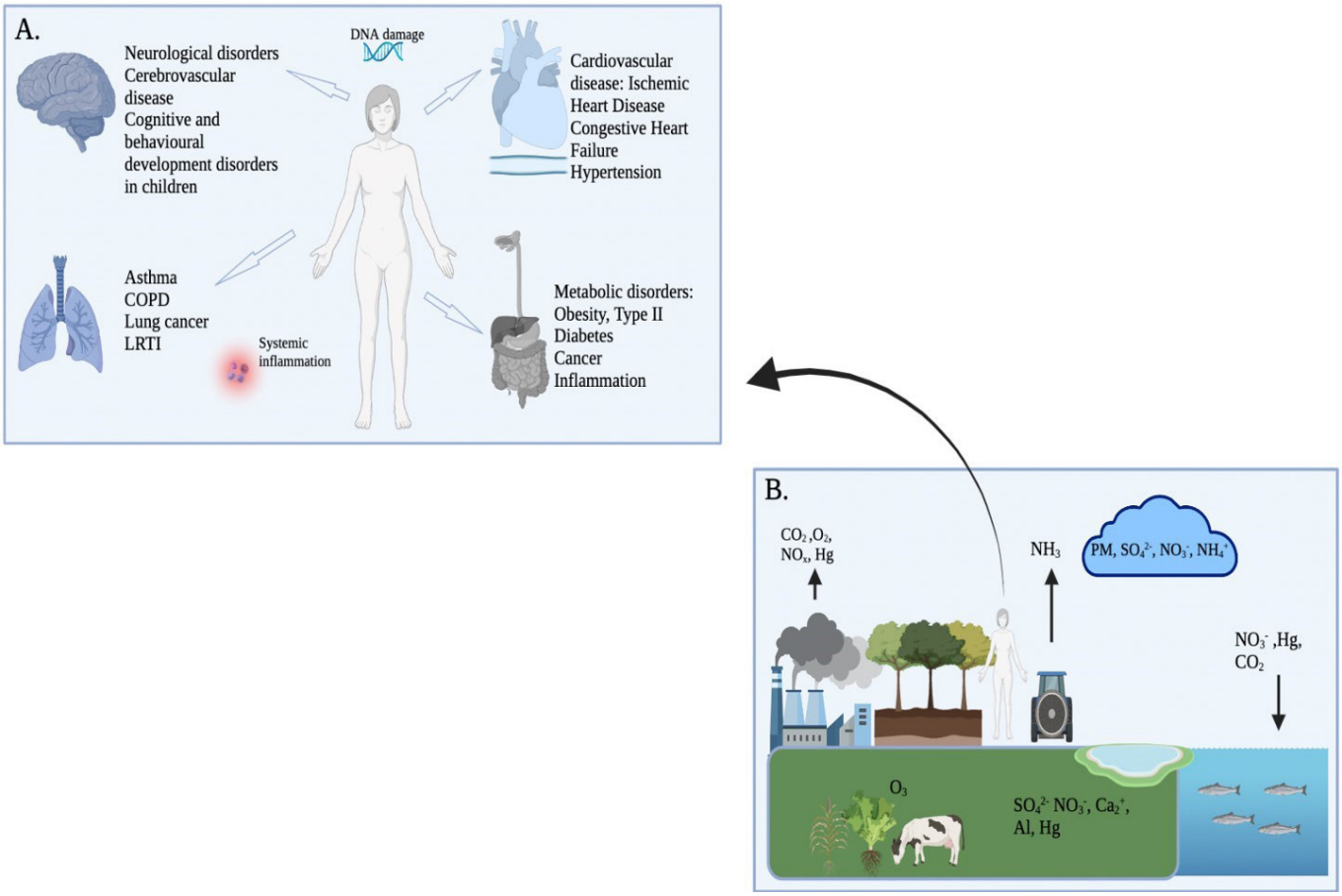

Figure 1. Schematic Overview of Air Quality and its Interplay Between the Environment and Human Health. A. Health conditions in various organ systems associated with poor air quality and $PM_{2.5}$ (2.5 µm and smaller) toxicity. Some mechanistic pathways include increase in cytochrome P450 enzymes of PM generating reactive oxygen species causing DNA damage and pro-inflammatory cytokines causing systemic inflammation. B. The anthropogenic sources (industry, power, transport, residential and agriculture) of air pollution affecting the environment and its ecosystem including human health. Fine PM (CO_2, O_2, NO_3^-, Hg) including $PM_{2.5}$ and ozone (O_3) have detrimental effects on crops, highlands, freshwater, coastal and marine waters exemplifying the planetary health concept.[12] Figure was created using BioRender (https://biorender.com/) and adapted from von Schneidemesser et al.[13] PM: Particulate matter; LRTI: Lower respiratory tract infection.

wood are combusted, is the second largest contributor.[2] With the advent of warmer and drier climates, combustion of fossil fuels exacerbates climate change by increasing greenhouse gas emissions and consequently escalating the propagation of wildfires.[2] There is an urgent need to leave the planet a better place for future generations as short-term exposure to air pollution is associated with reduced lung function, delayed psychomotor development, and lowered IQ in children.[8] Air pollution should embody the planetary health concept, which highlights the interdependence between the health of humans and the planet.[12] Changes to natural systems, such as increased ground-level ozone, damage food crops through eutrophication and consequently acidify environmental waters and amplify mercury bioaccumulation in oceans (Figure 1).[13] This causal sequence of global environmental changes from air pollution affects agricultural productivity, food security, and human health.[13]

Environmental Health Inequality

Given that an estimated 7 million deaths per year are caused by air pollution, this threat is underappreciated by the public.[1] Some media reports are attempting to generate awareness around the topic, but most fail to communicate the severity of the issue. A recent study showed that fewer than 40% of news articles discussing air pollution mentioned the health risks posed for humans, and less than 10% discussed what actions individuals can take to minimise their risk of developing health complications.[14]

The general ignorance surrounding air quality is apparent when using sub-Saharan Africa as an example. Studies have found that air pollution in Africa is responsible for more premature deaths on the continent than communicable diseases like HIV/AIDS and malaria, yet most public discourse and fear are centred around communicable diseases.[15] The recognition of the dangers posed by these diseases has led to the development of treatment and the establishment of preventative measures which have led to a decrease in overall mortality linked to these conditions.[15] While this is a step in the right direction, similar or greater attention should be given to the impacts of air pollution on the African population, to address this issue as communicable diseases have been addressed. The nations that comprise Sub-Saharan Africa are undergoing rapid urbanisation, increasing not only in the number of people exposed to outdoor air pollution, but also the overall pollution levels.[15] The biggest contribution to outdoor air pollution is the use of poor-quality fuels and older model cars sold by Europe, the United States, and Japan after the catalytic converters and air filters have been

removed. These nations sell cars to Africa with environmental standards that are prohibited within their own jurisdictions.[15]

Indoor air pollution is another major factor, stemming from traditional cooking practices and burning of household waste. As a result, women are exposed to seven times greater particulate pollution than men.[15] Thus, these countries are facing a triple threat from poor air quality - urbanisation and its health issues, the uninterrupted burden of infectious diseases, and the lack of national data regarding air quality.[15] There are very few studies on the health impacts of air pollution in sub-Saharan Africa; a recent assessment showed that 9 out of 12 were focused on South Africa.[15] While reports demonstrate that sub-Saharan Africa has the highest burden of disease as a result of poor air quality, these assessments rely on estimates from the rest of the world due to governments' lack of ability to monitor their own air quality.

Carbon leakage, the phenomenon in which countries reduce their emissions by outsourcing them to lower income countries, is an essential part of the discussion around air quality and global inequality.[16] This issue is most apparent in the case of the United States outsourcing their emissions to China. Importantly, this is also observable where developed nations that did not commit to the Kyoto protocol are outsourcing their emissions to developing nations.[16] Carbon leakage is an example of inequality in air pollution that is directly influenced by national policy.

Role of Healthcare Professionals

While the media and governments could be doing more to create a sense of urgency among the public, it can be argued that healthcare professionals are at least partly to blame for the lack of awareness surrounding this issue. Even physicians do not consider air pollution to be as significant as other risk factors causing disease. There are resources available online that report the quality of air in certain locations, but these resources are arguably useless if the public is not informed that the current state of air quality poses a legitimate threat. Physicians have a duty to inform their patients of risk factors that may be impacting their health negatively, and air pollution is no exception, yet there is minimal discussion of air pollution in health consultations. An increasing interest for climate change and its implications to be integrated into medical school curricula was shown in a recent study which reported that only 11% of medical schools across 112 countries have incorporated air pollution into their undergraduate educational programmes.[17] Healthcare professionals must use a holistic approach in providing lifestyle advice to patients as part of daily practice.

Mitigating Health Consequences of Air Pollution

Despite the enormity of air pollution and its burden on global health there are strategies, both reasonable and attainable, that can help mitigate this issue. For example, by implementing strict policy changes and aggressive air quality management programs, China succeeded in reducing particulate pollution by 29% between 2013 and 2019, increasing life expectancy by 1.5 years.[2] This was attributed to government strategies such as reducing emissions of coal plants or replacement with natural gas, generating renewable energy, reducing metal use in industry and car usage, utilising political incentives, and incorporating transparency with better enforcement.[2] The implementation of air quality monitors minimised underreporting of pollution, allowing the public to assess risk exposure. To contextualise China's success, the United States achieved this level of decline after three decades, and Europe after two.[2]

There is an urgent need for the standardisation of air quality measurement and programmes on a global scale. A reduction in fine PM has been shown to contribute to the greatest degree of public health benefits.[18] Even a small reduction in concentration for a large population can decrease mortality. Not only do health benefits of improved air quality increase immediately after fossil fuel emissions are reduced, but these benefits also offset the costs associated with implementing policies and renewable energies. Carbon taxing can also be introduced in more countries to reduce carbon leakage. Improvements in air quality are easily counterbalanced with increasing pollution in other areas, emphasising the requirement for a comprehensive planetary health approach.[12]

Current efforts to improve urban air quality include a significant focus on the transition to sustainable energy and transportation through the electrification of transportation. Conclusively, electrification is proposed as a means to improve local air quality. However, caution is required as electrification may increase power plant combustion and emissions around electrical generating units.[18] There is also need for simpler air quality measuring tools similar to those in China that can be utilised by the public to protect those most at risk. This approach allows the public to make better-informed decisions by evaluating their own risk. The COVID-19 emergency has contributed to a greater public awareness of the health benefits of cleaner air and less noisy urban environments.[19] It will be of interest to observe the long-term environmental legacy of the pandemic on individual travel and consumption behaviours. Novel technologies will play an important role in this regard. Whether recently launched wearable air purifiers will have a role in protecting individuals from the harmful effects of air pollution remain to be seen.[20]

Conclusion

There are two main fronts in the campaign against pollution, one being the reduction of anthropogenic emissions through public and government policy, and the other being the introduction of novel attempts to decrease pollution and other innovative research to develop new approaches that will ultimately lead to the amelioration of global health.[2] A neglected strategy is to increase public and clinician awareness and understanding about air pollution and its health effects. Future research should examine the extent to which the COVID-19 pandemic has shifted public attitudes towards a greater commitment to environmental sustainability and cleaner air for all.

Authors' Contributions

GTF was responsible for study conception. All authors contributed

equally to the research and preparation of this manuscript. The final version of the manuscript was approved by all authors.

Conflict of Interest Disclosures

The authors have no conflicts of interest to declare.

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References

1. World Health Organization. Air Pollution. 2021. Available from: https://www.who.int/health-topics/air-pollution#tab = tab_1. Accessed October 30, 2021.
2. Lee K, Greenstone M. Annual Update. Air Quality Life Index; 2021.
3. Oh WW, Nasir N, Flaherty GT. Scientometric evaluation of published articles in travel medicine and global health. Int J Travel Med Glob Health. 2021;9(2):73-77. doi:10.34172/ijtmgh.2021.12.
4. Flaherty GT, Lim Yap K. Bibliometric analysis and curriculum mapping of travel medicine research. J Travel Med. 2017;24(5):tax024. doi:10.1093/jtm/tax024.
5. Vilcassim MJR, Gordon T, Sanford CA. Does air pollution contribute to travelers' illness and deaths?-evidence from a case report and need for further studies. J Travel Med. 2018;25(1):tay002. doi:10.1093/jtm/tay002.
6. Vilcassim MJR, Callahan AE, Zierold KM. Travelling to polluted cities: a systematic review on the harm of air pollution on international travellers' health. J Travel Med. 2021;28(4):taab055. doi:10.1093/jtm/taab055.
7. Guindi MN, Flaherty GT, Byrne M. Every breath you take: how does air pollution affect the international traveller? J Travel Med. 2018;25(1):tay021. doi:10.1093/jtm/tay021.
8. Mukherjee A, Agrawal M. A global perspective of fine particulate matter pollution and its health effects. Rev Environ Contam Toxicol. 2018;244:5-51. doi:10.1007/398_2017_3.
9. Vilcassim MJR, Thurston GD, Chen LC, et al. Exposure to air pollution is associated with adverse cardiopulmonary health effects in international travellers. J Travel Med. 2019;26(5):taz032. doi:10.1093/jtm/taz032.
10. Newman JD, Bhatt DL, Rajagopalan S, et al. Cardiopulmonary impact of particulate air pollution in high-risk populations: JACC state-of-the-art review. J Am Coll Cardiol. 2020;76(24):2878-2894. doi:10.1016/j.jacc.2020.10.020.
11. Walsh SM, Flaherty GT. Health risks and benefits of international travel for adult patients with asthma. Int J Travel Med Glob Health. 2021;9(4):149-154. doi:10.34172/ijtmgh.2021.25.
12. Pongsiri MJ, Bickersteth S, Colón C, et al. Planetary health: from concept to decisive action. Lancet Planet Health. 2019;3(10):e402-e404. doi:10.1016/s2542-5196(19)30190-1.
13. von Schneidemesser E, Driscoll C, Rieder HE, Schiferl LD. How will air quality effects on human health, crops and ecosystems change in the future? Philos Trans A Math Phys Eng Sci. 2020;378(2183):20190330. doi:10.1098/rsta.2019.0330.
14. Ramondt S, Ramírez AS. Media reporting on air pollution: health risk and precautionary measures in national and regional newspapers. Int J Environ Res Public Health. 2020;17(18):6516. doi:10.3390/ijerph17186516.
15. Abera A, Friberg J, Isaxon C, et al. Air quality in Africa: public health implications. Annu Rev Public Health. 2021;42:193-210. doi:10.1146/annurev-publhealth-100119-113802.
16. Nielsen T, Baumert N, Kander A, Jiborn M, Kulionis V. The risk of carbon leakage in global climate agreements. Int Environ Agreements Int Environ Agreem Polit Law Econ. 2021;21(2):147-163. doi:10.1007/s10784-020-09507-2.
17. Omrani OE, Dafallah A, Paniello Castillo B, et al. Envisioning planetary health in every medical curriculum: an international medical student organization's perspective. Med Teach. 2020;42(10):1107-1111. doi:10.1080/0142159x.2020.1796949.
18. Gallagher CL, Holloway T. Integrating air quality and public health benefits in U.S. decarbonization strategies. Front Public Health. 2020;8:563358. doi:10.3389/fpubh.2020.563358.
19. Yang M, Chen L, Msigwa G, Tang KHD, Yap PS. Implications of COVID-19 on global environmental pollution and carbon emissions with strategies for sustainability in the COVID-19 era. Sci Total Environ. 2022;809:151657. doi:10.1016/j.scitotenv.2021.151657.
20. The Guardian. Dyson launches Zone air purifying Bluetooth headphones with visor. *The Guardian*. March 30, 2022. https://www.theguardian.com/technology/2022/mar/30/dyson-launches-zone-air-purifying-bluetooth-headphones-with-visor. Accessed March 31, 2022.