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Markus Hilpert,
Columbia University, United States

*CORRESPONDENCE
Reginald Quansah
✉ rquansah@ug.edu.gh

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Editorial: Air pollution levels, health effects, and interventions

Reginald Quansah[1]*, Prince M. Amegbor[2], Godfred O. Boateng[3] and Caroline Ochieng[4]

[1]Department of Biological, Environmental, and Occupational Health Sciences, School of Public Health University of Ghana, Accra, Ghana, [2]School of Global Public Health, New York University, New York, NY, United States, [3]School of Global Health, Faculty of Health, York University, Toronto, ON, Canada, [4]Ryan Institute, National University of Ireland Galway, Galway, Ireland

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Editorial on the Research Topic
Air pollution levels, health effects and interventions

Introduction

Every breath we take is a reminder of the invisible threat that surrounds us. Air pollution, both ambient (outdoor) and household (indoor), remains a critical global issue, impacting health, ecosystems, and climate. Despite increased awareness and technological advancement, air quality continues to deteriorate in many regions. Nearly 99% of the global population breathes air exceeding WHO guidelines for fine particulate matter (PM2.5). Low- and middle-income countries face the highest exposure levels (http://www.who.int/health-topics/air-pollution). Key contributors include household combustion devices, motor vehicles, industrial facilities, forest fires, and agricultural practices (1).

Globally, ambient air pollution causes 4.2 million deaths annually due to diseases such as ischaemic heart disease (25%), stroke (24%), chronic obstructive pulmonary disease (COPD) (43%), acute lower respiratory infections (17%), and lung cancer (29%) (2, 3). When combined with household air pollution, this statistic rises to almost 7 million premature deaths annually (4). The association between air pollution and various diseases, such as heart disease, stroke, COPD, lung cancer, and acute respiratory infections, is well documented. Evidence remains limited for conditions such as asthma in low- and middle-income countries, as well as for neurodegenerative and psychiatric disorders, suicide, immune-mediated conditions, rheumatic diseases, and inflammatory bowel disease (4, 5). Recent outbreaks of emerging infectious diseases, such as COVID-19 and monkeypox, have posed new challenges to public health and heightened interest in the interplay between air pollution and infectious diseases (6–8). However, assessments of their impact across a broad spectrum of infectious diseases are still limited (9). This research gap highlights the need for comprehensive studies on the impact of various environmental factors, including air pollution, climate change, and urbanization, on the transmission dynamics of infectious diseases. Understanding these relationships facilitates the formulation of public health strategies that are more effectively tailored to mitigate the impacts of future outbreaks and safeguard at-risk populations.

A systematic review and meta-analysis by Abbah et al. of six studies that looked at the link between long-term exposure to air pollution and asthma in low- and middle-income countries found a weak but significant link between a 10 $\mu g/m^3$ increase in PM2.5 exposure and asthma risk, although variability among studies remained. Variations in study design, demographic variables, and regional environmental conditions may account for this heterogeneity. Additional studies are needed to clarify these inconsistencies and to enhance comprehension of the mechanisms linking air pollution to asthma prevalence in various contexts.

In their seminal paper, Lin et al. employed time-series analysis to individually implement single and distributed lag models to evaluate the exposure-lag response relationship for 43 national notifiable infectious diseases (NNID) from 2013 to 2019. A 10 $\mu g/m^3$ increase in ozone was linked to a higher incidence of blood-borne and sexually transmitted infections as well as total NNID. The results highlight the significant public health implications of air quality for infectious disease dynamics. This research underscores the urgent need for policymakers to consider environmental factors when developing strategies to mitigate the spread of these diseases. Integrating air quality data into public health frameworks enhances our comprehension of the relationship between environmental variables and disease transmission. Proactive strategies may result in enhanced health outcomes and more efficient interventions for at-risk populations. Ultimately, cultivating collaboration between environmental scientists and public health professionals will be essential in tackling these difficulties. This interdisciplinary approach fosters a thorough grasp of the processes affecting disease transmission and facilitates innovative strategies to protect public health against emerging environmental hazards.

Again, a systematic review and meta-analysis of eleven studies identified statistically significant associations between air pollution and inflammatory bowel disorders. Five mechanism-based studies of Olstrup et al. revealed that inhalation of air pollution alters gut microbiota, metabolic processes in the gut, and immune system responses, all contributing to the onset of inflammatory bowel disease. By examining the complex interplay between environmental influences and gut health, researchers can enhance healthcare procedures and optimize patient outcomes. As new studies emerge, it becomes increasingly clear that a holistic approach to health must consider not only genetic predispositions but also the broader ecological influences that shape our well-being.

The World Health Organization has outlined a strategic framework for 2023–2030 aimed at addressing air pollution and its associated health impacts. This framework focuses on the enhancement of knowledge through public education, fortification of institutional capacity, and the promotion of leadership and coordination in the management of air pollution (10). This framework emphasizes that effective interventions against air pollution require coordinated efforts among governments, communities, industries, and individuals. Implementation of national standards in accordance with WHO guidelines is essential. Investments in clean energy research, monitoring systems, and public education are crucial. Cities must incorporate public health considerations into urban planning and implement sustainable practices in transportation, energy consumption, and waste management. Citizens ought to promote clean environments by ensuring that governments are accountable and embracing sustainable lifestyles (10). Fostering a culture of environmental stewardship is essential, as it enables individuals to make informed decisions that benefit the health of the planet. Collaborative initiatives among diverse stakeholders can enhance these efforts, ensuring that improvements in air quality are both effective and sustainable in the long term.

Finally, Liang et al. (11) examined the impact of urban spatial development modes on air pollution from the perspective of urban geometric forms. They primarily evaluate urban geometric form using the average geographic distance between any point in the city and the city centre. The study indicates that compact urban geometric forms notably decrease PM2.5 levels by mitigating traffic congestion and lowering residential energy use. An analysis of heterogeneity indicates that cities characterized by lower population density significantly contribute to reductions in air pollution through the adoption of compact spatial development strategies. Even though compact urban forms pose environmental challenges, including urban heat islands and air pollution; however, these issues can be effectively addressed through strategic urban planning and design (12). The advantages of compactness—such as reduced emissions, efficient resource utilization, and the preservation of natural habitats—generally outweigh the disadvantages, rendering it a significant strategy for sustainable urban development.

Conclusions

While the health impacts of air pollution can be dire, effective measures such as transitioning to renewable energy, developing urban green spaces, improving transportation systems, and enforcing stricter emission regulations provide viable paths to cleaner air and healthier communities. These approaches decrease disease burdens while also addressing climate change by reducing greenhouse gas emissions. Finally, mitigating air pollution requires a collaborative effort among institutions, businesses, and citizens. Prioritizing sustainable practices and regulations allows for the protection of public health and conservation of ecosystems while ensuring a livable future for future generations.

Author contributions

RQ: Writing – review & editing, Writing – original draft, Conceptualization. PA: Writing – review & editing. GB: Writing – review & editing. CO: Writing – review & editing.

Conflict of interest

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