EURASIAN EXPERIMENT JOURNAL OF MEDICINE AND MEDICAL SCIENCES (EEJMMS) ISSN: 2992-4103
©EEJMMS Publications Volume 5 Issue 2 2024

The Impact of Air Quality on Public Health

Rukundo Sande Kibuuka

Faculty of Science and Technology Kampala International University Uganda

ABSTRACT

This research examines the impact of air quality on public health, including the short- and long-term impacts of exposure to pollutants such as particulate matter (PM), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and ozone (O_3). Urbanization and industrialization have deteriorated air quality in major cities globally, increasing sickness and mortality. The study demonstrates how poor air quality contributes to respiratory and cardiovascular health issues, particularly in vulnerable populations such as children, the elderly, and those with pre-existing diseases. Recommendations are made for policy and public health actions to improve air quality and reduce health hazards.

Keywords: Air quality, Public health, Particulate matter (PM), Nitrogen dioxide (NO_2), Sulfur dioxide (SO_2), Ozone (O_3).

INTRODUCTION

Public health depends on several determinants, one of which is clean air. When measured as part of air quality, it is thus indispensable for the well-being of the population. Global levels of ambient air pollution have also been reported to be alarmingly high, and there are now grave concerns regarding air quality in most major cities across the world. One of the best indicators of population exposure to emissions is the level of air pollution, and one of the most reliable indicators of good air quality is the fact that there is a very low level of air pollution. In this context, it is urgent to define urban air quality and to inform cities about some of the likely implications urban air quality will have on public health [1]. The public health impacts of air quality are generally categorized according to the severity and onset of effects. Different health impacts, outcomes, and air pollutants have various short- and long-term toxicities. Depending on the duration and concentration, exposure to a particular air pollutant has the potential to elicit effects delayed in time or rapidly. Moreover, there is a general consensus that effects are typically dose-dependent. Those which have a threshold equation, based on what is safe and what is not, are called 'standards', while those which might take into account the background level of air pollution are called 'guidelines'. The objective of this paper is to present evidence of the relationship between urban air pollution and public health. The composition of resourceful air and pollutants with significant public health impact will be identified. Following this, the concentration recommended for each of the pollutants will be reviewed [2].

Understanding Air Quality

We hear a lot about air pollution and bad air quality but not about what those are. In this text, we will provide you with the definitions of good and bad air quality in a little more detail. For most air pollutants, low levels or exposure to them only have a minor effect on a small part of the population, but effects increase with exposure level, and moving from mildly harmful to very poor air can be very sudden. In the UK, we monitor urban background air quality and check that emissions of seven key pollutants do not exceed certain air quality levels, which are legally set in an air quality strategy called objectives. We use the Air Quality Index to communicate air quality levels to the public. Seven of the emissions are measured on the UK Air Quality Index; these are the pointer pollutants. There are two types of air quality in the UK: one is good (low risk/harm to health) and one is bad (high risk/harm to health) [3]. Air quality is a result of complex interactions between natural processes, human activities, and climatic influences. The quality of the air due to origin is classified according to the parameters of well and/or poorly mixed air. Well-mixed air quality is defined by low-density concentrations and a big expansive horizon. Poorly mixed air is a polluted environment with toxic gases and particulate pollution. Throughout history, air quality has been a growing public concern. It has also been a driving force for regulation in many nations since the 19th century. Urban and industrial smogs have been tied to factories since the 18th century, which led to much cleaner fuels being used as the industrial revolution grew. The signature of poor-quality air has changed in lockstep with the changes in urbanization and industrial pollution. Before the great factories and smogs of the 18th and 19th centuries, air quality was tainted by cooking fires and is now a mix of industrial pollutants and exhaust emissions from motor vehicles. One hundred years ago, natural pollution was the largest source of pollutants in the natural air – domestic and industrial sectors [4].

Key Pollutants in The Air

Particulate matter (PM) and gaseous pollutants, such as nitrogen dioxide (NO2), sulfur dioxide (SO2), and ozone (O3), are pollutants that can degrade air quality. The characteristics, sources, and health effects of these pollutants are summarized. However, it is important to note that the pollutants are not present individually in the atmosphere. During many air pollution episodes, various pollutants coexist. Current scientific evidence and the results of numerous epidemiological studies have shown excess mortality and morbidity related to long-term or chronic exposures to PM, NO2, SO2, and O3. Finally, it is also important to remember that some health conditions can be exacerbated by pollutants, which can alter lung function and trigger cardiovascular effects while affecting the progression of several diseases. This means that one individual is not exposed to one pollutant but to a combination of several pollutants [5]. Further, particulate matter (PM), NO2, SO2, and other pollutants do not appear in isolation in the atmosphere. Often, there is co-pollution of a variety of pollutants. The effects of this co-pollution are not addressed in the subsequent sections. As mentioned earlier, these pollutants emerge from a variety of natural and anthropogenic sources. Human activities, such as the burning of fossil fuels, transportation, energy generation, industry, agriculture, and the diverse proposition of chemical reagents, are generally linked with the release of these pollutants into the atmosphere. Despite the progress already made, the control of atmospheric pollution has not become a worldwide public health priority. This document highlights several atmospheric pollutants believed to increase the risk of noncommunicable diseases and adversely affect public health diseases that currently account for most deaths globally [6].

Health Effects of Poor Air Quality

Poor air quality has far-reaching direct and indirect impacts on public health. Some of the more immediate health effects stemming from exposure to air pollutants include premature mortality and various changes in lung, respiratory, and cardiovascular functions, as well as increased frequencies of healthcare visits and admissions for pneumonia and asthma. Although research on this topic is ongoing, adequate evidence shows direct links between levels of exposure to pollutants in the air and the development of several specific conditions, from hypertension and lung cancer to lung infections and low birth weight in newborns. Air quality is also closely related to several emerging health problems, including Alzheimer's disease, diabetes, obesity, and neurodegenerative disorders. Poor air quality tends to worsen these conditions, especially in populations already vulnerable because of age, ethnicity, or pathology. Individuals with pre-existing ailments are known to be more likely to experience these conditions, which often require long-term care with additional costs and investment of health resources. The causal chain linking exposure to air pollutants to the occurrence of symptoms may have begun many years earlier, in many cases during fetal life. Emission data is insufficient to provide an understanding of the scales of the effects of air pollution on public health. However, at times, pollutant diffusion is not directly proportional to its effects on human beings. In measuring the health effects of changes in air quality, we therefore strive to base our considerations on the responses of various interdependent systems to changes in air quality. Public efforts can therefore yield benefits by reducing the health effects of air pollution. Some conditions require that we act in the short term for several generations to come [7, 8].

Respiratory Effects

The respiratory system is the major target of exposure to air pollution. Air pollutants cause mild irritation of the respiratory system, changes in lung function, and growth. Although it is linked to the onset and exacerbation of morbidity and mortality from respiratory diseases, such as asthma, chronic obstructive pulmonary disease, and lung cancer, many of these diseases or the exacerbations of respiratory syndromes are related to exposure to major air quality indicators, such as particulate matter, nitrogen dioxide, and ground-level ozone. The relationship between exposure to air pollution and exacerbation of a respiratory symptom in a patient with chronic disease is stronger than the relationship with an acute symptom. Increased morbidity and mortality occur in children and the elderly, the age group with high health service usage [9]. The exposure to polluting particles and their smaller particle size, along with many chemical substances, might produce inadequate functioning of the pulmonary epithelial and immunological barrier and lead to systemic inflammation, which can contribute to the onset of many chronic diseases. Epidemiological studies associate high levels of air pollutants with the exacerbation of several chronic respiratory diseases, directly impacting the increase in hospital demand

and healthcare costs. From the first observations of the descriptive relationship between air pollution and increased morbidity and mortality due to respiratory diseases, many researchers have carried out studies to better understand the relationship between air pollution and respiratory diseases. The increased levels of asthma attacks in recent years might even have a psychosocial issue related to the recent increase in air pollution. High levels of air pollution were significantly associated with decreased quality-of-life scores and increased respiratory symptoms [10].

Cardiovascular Effects

Cardiovascular disease is significantly linked to high air pollution levels, showing increased prevalence and severity. Research indicates a strong relationship between particulate matter and higher risks for short-term death and hospital admissions due to chronic ischemic heart disease. Long-term exposure leads to hypertension and various heart-related conditions, including stroke. Particulate matter, containing heavy metals and organic compounds, is thought to contribute to cardiovascular risk. It may disrupt normal physiological functions by causing inflammation and oxidative stress. Inhalation of soluble components promotes blood coagulation, leading to complications like heart attacks and heart failure, especially during extreme heat and air pollution events. Studies found that cardiac arrests and related admissions surged after tropical storms, with older adults and men facing greater risks [11].

Vulnerable Populations

In general, children are more vulnerable than adults to the health impacts of exposure to air pollution. Other at-risk populations include the elderly, those with pre-existing health conditions, especially respiratory or cardiovascular issues, and individuals of lower socioeconomic status. Although the increased risk that these populations face can be partially attributed to pre-existing conditions, it is also connected to the aforementioned socioeconomic factors. Location and living conditions also play an important role. For example, many low-income families live close to major roads, making them more likely to be exposed to harmful pollutants. Furthermore, other factors such as occupation, diet, and lifestyle can exacerbate the impacts of air pollution [12]. Disproportionately, it tends to be those who already live marginalized lives that are more exposed to air pollution and carry a greater burden of its sidelining health impacts. This can compound already poor health status and limited access to resources to change either exposure or health outcomes, resulting in an unfair health burden. Major discrepancies are evident in the rate of hospital admissions for respiratory problems, with as much as a four-fold difference between countries with the highest and lowest rates. There is also great geographical variance in the prevalence of childhood asthma: the proportion of children suffering from the condition has been estimated to be as low as 7% in one capital, against 32% in another. It is important to recognize these vulnerable populations: not all individuals are equally susceptible to the health impacts of poor air quality. These groups often have more contact with healthcare services, and this interaction can be vital in providing information and support in the wake of a polluted air event. More targeted policies and interventions aimed at protecting the decreasing levels of air quality are needed to protect human health [13].

Mitigation Strategies

Air quality is a direct reflection of the emissions released from local and non-local sources. To improve air quality, sectors including transportation and industry need to abide by regulatory frameworks set out by national and transnational governments. For the transportation sector, the regulating entity that sets targets for emissions is the relevant organization for cars under the applicable conventions. Regulating entities continue to press for the reduction of sulfur emissions by implementing cleaner ships in designated areas while also investigating potential financial and environmental implications. To mitigate emissions at the local scale, it would be beneficial for policy to center on changing the source of emissions to one of minimal pollutants such as renewable energy. Through the introduction of cleaner fuels and renewable energy, emissions of concern can be greatly reduced if not eliminated. The combination of technology and policy can achieve emission reductions and maximize public health benefits whereby industry and transportation can increase efficiency by reducing pollutants. Technology and regulators are the two necessary approaches to reducing pollutants at the source of emissions [14].

In terms of changing the source of emissions to one of minimal pollutants, a complete transition of fuels and energy consumption would need to occur. Working with communities to change the source of residential emissions to cleaner energy sources would also have direct public health and emission-reduction benefits. Engaging communities through public awareness campaigns would foster knowledge of severe health risks community members are subject to. The serious health implications of air pollution in small communities could spur the onset of beneficial public health initiatives. The impacts on humans, ecosystems, and the costs of climate change are increasingly well documented, and improving air quality is an effective way to potentially mitigate these effects. The results of any mitigation strategies must include a diverse group of stakeholders such as research institutions, governments, local communities, and organizations. The best type of approach is inclusive; stakeholders should recognize the interconnection between the social, economic, and environmental considerations in any given region. The implementation of policy is top-down with support from governments. There are instances of some successful policy initiatives. Many harbors and port cities have drastically reduced atmospheric emissions by enforcing the idling of ships while at berth and verifiable enforcement to comply with the regulatory framework. Researchers exploring health effects are increasing, but the population-level epidemiological research is not keeping up. The interplay of industrial activities and policy creates risks for communities, and dedicated health research is imperative to quantify these risks [15].

CONCLUSION

The evidence presented demonstrates the profound impact of poor air quality on public health, particularly in urban settings where pollution levels are highest. Exposure to harmful pollutants such as PM, NO_2, SO_2, and O_3 is associated with respiratory and cardiovascular diseases, leading to premature deaths and increased healthcare burdens. Vulnerable populations, including children, the elderly, and individuals with pre-existing conditions, are disproportionately affected. Immediate action through stricter environmental regulations, improved air quality monitoring, and targeted public health interventions is essential to mitigate these impacts and protect human health. Future efforts should focus on reducing emissions, promoting clean energy alternatives, and raising public awareness about the importance of maintaining healthy air quality levels.

REFERENCES

1. Peláez LM, Santos JM, de Almeida Albuquerque TT, Reis Jr NC, Andreão WL, de Fátima Andrade M. Air quality status and trends over large cities in South America. Environmental Science & Policy. 2020 Dec 1;114:422-35. [HTML]
2. Tiotiu AI, Novakova P, Nedeva D, Chong-Neto HJ, Novakova S, Steiropoulos P, Kowal K. Impact of air pollution on asthma outcomes. International journal of environmental research and public health. 2020 Sep;17(17):6212. mdpi.com
3. Tomson M, Kumar P, Barwise Y, Perez P, Forehead H, French K, Morawska L, Watts JF. Green infrastructure for air quality improvement in street canyons. Environment international. 2021 Jan 1;146:106288. sciencedirect.com
4. Fowler D, Brimblecombe P, Burrows J, Heal MR, Grennfelt P, Stevenson DS, Jowett A, Nemitz E, Coyle M, Liu X, Chang Y. A chronology of global air quality. Philosophical Transactions of the Royal Society A. 2020 Oct 30;378(2183):20190314. royalsocietypublishing.org
5. Burnett R, Cohen A. Relative risk functions for estimating excess mortality attributable to outdoor PM2. 5 air pollution: Evolution and state-of-the-art. Atmosphere. 2020 Jun 3;11(6):589.
6. Münzel T, Steven S, Frenis K, Lelieveld J, Hahad O, Daiber A. Environmental factors such as noise and air pollution and vascular disease. Antioxidants & redox signaling. 2020 Sep 20;33(9):581-601.
7. Rosário Filho NA, Urrutia-Pereira M, d'Amato G, Cecchi L, Ansotegui IJ, Galán C, Pomés A, Murrieta-Aguttes M, Caraballo L, Rouadi P, Annesi-Maesano I. Air pollution and indoor settings. World Allergy Organization Journal. 2021 Jan 1;14(1):100499. sciencedirect.com
8. Grigorieva E, Lukyanets A. Combined effect of hot weather and outdoor air pollution on respiratory health: Literature review. Atmosphere. 2021 Jun 19;12(6):790.
9. Xue Y, Chu J, Li Y, Kong X. The influence of air pollution on respiratory microbiome: A link to respiratory disease. Toxicology letters. 2020 Nov 1;334:14-20.
10. Xue Y, Chu J, Li Y, Kong X. The influence of air pollution on respiratory microbiome: A link to respiratory disease. Toxicology letters. 2020 Nov 1;334:14-20.
11. Domingo JL, Rovira J. Effects of air pollutants on the transmission and severity of respiratory viral infections. Environmental research. 2020 Aug 1;187:109650.
12. Hayes RB, Lim C, Zhang Y, Cromar K, Shao Y, Reynolds HR, Silverman DT, Jones RR, Park Y, Jerrett M, Ahn J. PM2. 5 air pollution and cause-specific cardiovascular disease mortality. International journal of epidemiology. 2020 Feb 1;49(1):25-35.
13. Dominski FH, Branco JH, Buonanno G, Stabile L, da Silva MG, Andrade A. Effects of air pollution on health: A mapping review of systematic reviews and meta-analyses. Environmental research. 2021 Oct 1;201:111487. [HTML]
14. Alvarez CH, Calasanti A, Evans CR, Ard K. Intersectional inequalities in industrial air toxics exposure in the United States. Health & Place. 2022 Sep 1;77:102886.

15. Wu P, Guo F, Cai B, Wang C, Lv C, Liu H, Huang J, Huang Y, Cao L, Pang L, Gao J. Co-benefits of peaking carbon dioxide emissions on air quality and health, a case of Guangzhou, China. Journal of Environmental Management. 2021 Mar 15;282:111796. [HTML]
16. DeBolt CL, Brizendine C, Tomann MM, Harris DA. Focus: Health Equity: Lung Disease in Central Appalachia: It's More than Coal Dust that Drives Disparities. The Yale journal of biology and medicine. 2021 Sep;94(3):477. nih.gov

CITE AS: Rukundo Sande Kibuuka (2024). The Impact of Air Quality on Public Health. EURASIAN EXPERIMENT JOURNAL OF MEDICINE AND MEDICAL SCIENCES 5(2):1-5