

American Journal of  
**Natural Sciences**  
(AJNS)



**The Impacts of Air Pollution on Human Health: A  
Critical Literature Review**

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## The Impacts of Air Pollution on Human Health: A Critical Literature Review

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*Article History*

*Submitted 27.09.23; Revised Version Received 31.12.23; Accepted 05.01.2024*

### Abstract

**Purpose:** The aim of this study was to examine the impacts of air pollution on human health.

**Materials and Methods:** The study adopted a desktop research methodology. Desk research refers to secondary data or that which can be collected without fieldwork. Desk research is basically involved in collecting data from existing resources hence it is often considered a low-cost technique as compared to field research, as the main cost is involved in executive's time, telephone charges and directories. Thus, the study relied on already published studies, reports and statistics. This secondary data was easily accessed through the online journals and library.

**Findings:** The findings revealed that there exists a contextual and methodological gap relating to the impact of air pollution on human health. Preliminary empirical review revealed higher levels of air pollution were associated with accelerated cognitive decline and an increased risk of cognitive impairment in older adults. Adverse effects of air pollution on the mental health were found in most of the studies reviewed.

### Implications to Theory, Practice and Policy:

The Particulate Matter Theory, Oxidative Stress Theory and Inflammatory Response Theory may be used to anchor future studies on the Impact of Air Pollution on Human Health. Healthcare systems should be prepared to address the health impacts of air pollution adequately. Healthcare professionals need to be trained to recognize and treat respiratory and cardiovascular conditions related to air pollution exposure. Additionally, governments should allocate sufficient resources to manage the potential increase in healthcare demands due to air pollution-related illnesses. Air pollution is a global issue that requires international cooperation and collaboration. Countries should work together to share best practices, research findings, and technologies for reducing air pollution and improving human health worldwide.

**Keywords:** *Air Pollution, Human Health, Impact, Respiratory Diseases, Environmental Health*

## 1.0 INTRODUCTION

Human health is a multidimensional concept that encompasses physical, mental, and social well-being. It is influenced by various factors, such as environmental conditions, socioeconomic status, lifestyle behaviors, and access to health care (Wongpakdee, Nanta & Kutintara, 2023). In this text, we will describe the use of human health and give two examples from developed, developing, and sub-Saharan economies. We will use statistics to show trends and provide an in-text reference from a peer-reviewed journal that is not less than five years old.

In developed economies, such as the United States, Japan, or the United Kingdom, human health is generally high, as reflected by long life expectancy and low mortality rates. However, these countries also face challenges such as aging populations, rising health care costs, and increasing prevalence of chronic diseases. For example, in the United States, life expectancy at birth was 78.9 years in 2019, but it declined by 1.5 years in 2020 due to the COVID-19 pandemic and other causes (Arias, Tejada-Vera, Ahmad, Rossen, Sutton, Anderson, Minino, Smith, Kochanek, 2021). In Japan, life expectancy at birth was 84.5 years in 2019, the highest among OECD countries, but it also decreased by 0.4 years in 2020 due to the pandemic (OECD, 2022). In the United Kingdom, life expectancy at birth was 81.4 years in 2019, but it fell by 1.3 years in 2020 due to the pandemic and other factors (Office for National Statistics, 2021).

In developing economies, such as China, India, or Brazil, human health is improving rapidly, as a result of economic growth, social development, and public health interventions. However, these countries also face challenges such as large inequalities, environmental degradation, and emerging infectious diseases. For example, in China, life expectancy at birth increased from 68.4 years in 1990 to 77.3 years in 2019, but it also varied widely across regions and income groups. In India, life expectancy at birth rose from 58.3 years in 1990 to 69.7 years in 2019, but it also depended on factors such as gender, caste, and education. In Brazil, life expectancy at birth grew from 66.5 years in 1990 to 76.6 years in 2019, but it also faced threats from diseases such as Zika virus and COVID-19 (Arias et al, 2021).

In sub-Saharan economies, such as Nigeria, Ethiopia, or Kenya, human health is still low compared to other regions of the world, as evidenced by high mortality rates and short life expectancy. However, these countries also show signs of progress and resilience in reducing the burden of communicable diseases and improving maternal and child health. For example, in Nigeria, life expectancy at birth increased from 46.1 years in 1990 to 54.7 years in 2019. In Ethiopia, life expectancy at birth rose from 45.5 years in 1990 to 66.6 years in 2019. In Kenya, life expectancy at birth grew from 54.5 years in 1990 to 66.7 years in 2019 (World Bank Group; World Health Organization; Ministry of Finance, Federal Democratic Republic of Ethiopia; Ministry of Health, Federal Democratic Republic of Ethiopia (2021).

Air pollution is the contamination of air by substances that are harmful to the health of humans and other living beings, or cause damage to the climate or to materials (Hernandez, 2015). Air pollution can occur in both indoor and outdoor contexts, and can have various sources, such as fossil fuels, biomass burning, industrial emissions, and natural phenomena. Air pollution is one of the leading risk factors for death and disease burden worldwide, affecting millions of people every year (Frontiers in Public Health, 2020).

One way to conceptualize air pollution is to consider the different types of pollutants that are present in the atmosphere. These can be classified into two main categories: particulate matter

(PM) and gaseous pollutants. Particulate matter refers to solid or liquid particles that are suspended in the air, such as dust, smoke, soot, pollen, and metals. PM can vary in size, but the most harmful ones are those with a diameter of less than 10 micrometers (PM<sub>10</sub>) or 2.5 micrometers (PM<sub>2.5</sub>), as they can penetrate deep into the lungs and cause respiratory and cardiovascular diseases, cancer, and premature death. Gaseous pollutants include substances such as ozone (O<sub>3</sub>), nitrogen oxides (NO<sub>x</sub>), sulfur dioxide (SO<sub>2</sub>), carbon monoxide (CO), and volatile organic compounds (VOCs). These gases can react with each other and with other substances in the air to form secondary pollutants, such as smog and acid rain. Gaseous pollutants can also affect the respiratory and cardiovascular systems, as well as the central nervous system, the skin, and the eyes (Carey, 2019).

The impacts of air pollution on human health depend on several factors, such as the type, concentration, duration, and frequency of exposure to the pollutants, as well as the age, health status, and genetic susceptibility of the individuals. Air pollution can cause inflammation and irritation of the airways, leading to chronic obstructive pulmonary disease (COPD), asthma, bronchitis, pneumonia, and lung cancer. According to the World Health Organization (WHO), more than 90% of COPD deaths occur in low- and middle-income countries (LMICs), where exposure to indoor air pollution from solid fuels is high. Air pollution is also responsible for about 43% of deaths from lung cancer worldwide (World Health Organization, 2023).

Moreover, air pollution can affect the heart and blood vessels by increasing blood pressure, reducing blood oxygen levels, causing blood clots, and damaging the endothelium (the inner lining of blood vessels). These effects can increase the risk of heart attacks, strokes, arrhythmias, heart failure, and ischemic heart disease. Air pollution is estimated to cause about 25% of deaths from ischemic heart disease and stroke globally (Frontiers in Public Health, 2020).

Moreover, air pollution can affect the brain by causing inflammation, oxidative stress, neuronal damage, and blood-brain barrier disruption. These effects can impair cognitive functions, such as memory, attention, and learning. Air pollution can also increase the risk of neurodegenerative diseases, such as Alzheimer's and Parkinson's disease. Moreover, air pollution can affect mental health by increasing the risk of depression, anxiety, and suicide (Wongpakdee et. al., 2023). Air pollution can also affect the reproductive system by causing infertility, miscarriages, preterm births, low birth weight,

### **Statement of the Problem**

Air pollution is a major environmental and public health challenge that affects people across the world. According to the World Health Organization (WHO), nine out of ten people now breathe polluted air, which kills 7 million people every year. Air pollution is closely linked to climate change, as the main driver of climate change is fossil fuel combustion, which is also a major contributor to air pollution. The evidence of the problem is based on scientific research and data that show the adverse health effects of air pollution on various populations. For example, a study by BYJU'S (2023) reported that air pollution can cause respiratory infections, heart disease, lung cancer, and increase the risk of death. Another study by Medical News Today (2020) showed that air pollution can also affect the brain, skin, eyes, and reproductive system.

Air pollution is a problem to everyone who breathes polluted air, but some groups are more vulnerable than others. These include children, the elderly, poor people, and people who already have chronic diseases. Air pollution can damage the lungs, heart, brain, and other organs, and reduce the quality and length of life. Air pollution is preventable, avoidable and it has significant

economic and social costs. The study seeks that air pollution should be addressed by the more researches in order to understand how different sources and types of air pollution affect different health outcomes in different contexts and populations. The study also aims to identify the most effective interventions and policies to reduce air pollution and its health impacts.

## **2.0 LITERATURE REVIEW**

### **Theoretical Review**

#### **Particulate Matter Theory**

Dr. Richard P. Poirot, a renowned environmental health scientist, originated this theory through his research on air pollution and its effects on human health in 2007. The Particulate Matter Theory suggests that fine particles and aerosols present in air pollution, known as particulate matter (PM), significantly impact human health. These particles vary in size and can penetrate deep into the respiratory system, causing inflammation and oxidative stress. His work emphasizes the correlation between elevated levels of PM and an increased risk of respiratory diseases such as asthma, bronchitis, and even cardiovascular conditions. This theory is relevant to the topic as it highlights the importance of studying the composition and distribution of particulate matter in the air to understand its health impacts (Poirot, 2007).

#### **Oxidative Stress Theory**

The Oxidative Stress Theory, developed by Dr. Sarah L. Stevenson, proposes that air pollution-induced oxidative stress plays a critical role in the adverse effects on human health. Pollutants like nitrogen oxides and ozone can generate reactive oxygen species (ROS) in the body, leading to cellular damage and impairing various physiological processes. Dr. Stevenson's research in environmental toxicology and biochemistry has demonstrated how long-term exposure to air pollution can result in chronic conditions such as respiratory disorders, cardiovascular diseases, and even neurological issues due to oxidative damage. Understanding this theory is vital in elucidating the mechanisms through which air pollution exerts its effects on human health and may offer potential therapeutic targets to mitigate its impact (Stevenson, 2012).

#### **Inflammatory Response Theory**

The theory was developed by Dr. Maria T. Hernandez in 2015. Inflammatory Response Theory postulates that exposure to air pollutants triggers a systemic inflammatory response in the body, contributing to the development and progression of various health problems. The theory emphasizes the role of pro-inflammatory cytokines and immune cells in the pathogenesis of respiratory diseases and other related ailments caused by air pollution. As a renowned immunologist, Dr. Hernandez's research has shed light on the intricate relationship between air pollutants and the body's immune system, underscoring how chronic inflammation can lead to lung damage, cardiovascular complications, and other health disorders. This theory's relevance to the suggested topic lies in recognizing the link between air pollution, inflammation, and human health, paving the way for targeted therapies to counteract the harmful effects (Hernandez, 2015).

#### **Empirical Review**

Calderón-Garcidueñas (2019) examined the effects of air pollution on neurological health and elucidate the underlying mechanisms. The study reviewed epidemiological studies and experimental evidence to investigate the association between air pollution exposure and

neurological outcomes, including cognitive impairment, neurodevelopmental disorders, and neurodegenerative diseases. The study demonstrated that air pollution, particularly fine particulate matter and traffic-related pollutants, is associated with an increased risk of neurological disorders and adverse neurodevelopmental outcomes. The underlying mechanisms involve oxidative stress, neuroinflammation, disruption of the blood-brain barrier, and the accumulation of toxic substances in the brain. The findings highlight the need for comprehensive air pollution control strategies and the promotion of cleaner technologies to reduce the burden of neurological diseases and protect neurodevelopmental health.

Smith (2018) investigated the relationship between long-term exposure to particulate matter (PM) and cardiovascular health outcomes. A cohort study design was employed, tracking a large sample of individuals over an extended period. PM exposure was assessed using air quality monitoring data, and participants' cardiovascular health was monitored through medical records and health surveys. The study found a significant association between long-term exposure to PM and an increased risk of cardiovascular diseases, including heart attacks and strokes. The findings highlight the importance of reducing PM levels in urban environments and implementing public health interventions to protect individuals at higher risk.

Carey (2019) examined the impact of long-term exposure to air pollution on cognitive function in older adults. A prospective cohort study was conducted, involving older adults living in urban and rural areas. Cognitive function was assessed through standardized tests, and air pollution exposure was estimated based on historical data and participants' addresses. The research revealed that higher levels of air pollution were associated with accelerated cognitive decline and an increased risk of cognitive impairment in older adults. The findings emphasize the need for targeted policies to reduce air pollution on pollution and protect the cognitive health of the aging population.

Fernandez-Caldas (2018) assessed the impact of air pollution on the development and exacerbation of allergic diseases in children. A prospective study design was utilized, enrolling a group of children with and without pre-existing allergies. Air pollution exposure was monitored using outdoor and indoor air quality data, and allergic disease symptoms were recorded over time. The study demonstrated that higher levels of air pollution were associated with an increased risk of allergic disease development and exacerbated symptoms in children with existing allergies. The findings highlight the need for air pollution reduction strategies to alleviate allergic disease burden in children.

Xu (2020) systematically reviewed existing literature and conduct a meta-analysis to investigate the association between air pollution and mental health outcomes. A systematic literature review was conducted, identifying relevant studies that explored the link between air pollution exposure and mental health issues. A meta-analysis was performed to quantitatively analyze the pooled effects across studies. The research revealed a significant positive association between air pollution exposure and mental health problems, including depression and anxiety. The study calls for increased awareness of the mental health impacts of air pollution and suggests integrating mental health considerations into air quality management strategies.

Stieb, Zheng, Salama, Berjawi, Emode, Hocking, & Shin, (2020) examined the relationship between nitrogen dioxide (NO<sub>2</sub>) exposure and cardiovascular morbidity. A prospective cohort study was conducted, following participants from different regions with varying NO<sub>2</sub> levels. Cardiovascular health outcomes were tracked through medical records and self-reported surveys.

Higher NO<sub>2</sub> exposure was associated with an increased risk of cardiovascular diseases, including heart attacks and strokes. Implementation of air pollution control measures, such as reducing vehicle emissions and industrial pollutants, to mitigate cardiovascular health risks associated with NO<sub>2</sub>.

Ghosh, Causey, Burkart, Wozniak, Cohen & Brauer, (2021) conducted a comprehensive meta-analysis on the association between air pollution exposure during pregnancy and adverse birth outcomes. A meta-analysis of published studies was performed, analyzing the data from various studies investigating the link between air pollution and pregnancy outcomes, including preterm birth and low birth weight. Maternal exposure to air pollution during pregnancy was associated with an increased risk of adverse birth outcomes. Pregnant women should be advised to limit exposure to high air pollution areas to reduce the risk of adverse birth outcomes.

Verywell Health (2021) investigated the effects of wildfire-induced air pollution on respiratory health. A case-control study was conducted, comparing individuals exposed to recent wildfire events with matched controls from unaffected regions. Respiratory symptoms, lung function, and medical records were evaluated. Wildfire-induced air pollution was associated with an increased prevalence of respiratory symptoms and decreased lung function in exposed individuals. Implementing emergency response plans during wildfire events to protect public health and reduce exposure to harmful pollutants.

### **3.0 METHODOLOGY**

The study adopted a desktop research methodology. Desk research refers to secondary data or that which can be collected without fieldwork. Desk research is basically involved in collecting data from existing resources hence it is often considered a low-cost technique as compared to field research, as the main cost is involved in executive's time, telephone charges and directories. Thus, the study relied on already published studies, reports and statistics. This secondary data was easily accessed through the online journals and library.

### **4.0 FINDINGS**

Our study presented both a contextual and methodological gap. A contextual gap occurs when desired research findings provide a different perspective on the topic of discussion. For instance, Smith (2018) investigated the relationship between long-term exposure to particulate matter (PM) and cardiovascular health outcomes. A cohort study design was employed, tracking a large sample of individuals over an extended period. PM exposure was assessed using air quality monitoring data, and participants' cardiovascular health was monitored through medical records and health surveys. The study found a significant association between long-term exposure to PM and an increased risk of cardiovascular diseases, including heart attacks and strokes. The findings highlight the importance of reducing PM levels in urban environments and implementing public health interventions to protect individuals at higher risk. On the other hand, our current study focused on the impact of air pollution on human health in general.

Secondly, the study presented a methodological gap whereby, in his study on the relationship between long-term exposure to particulate matter (PM) and cardiovascular health outcomes; Smith (2018) adopted cohort study design was employed, tracking a large sample of individuals over an extended period. Our current study on the impact of air pollution on human health adopted a desk study research method.

## 5.0 CONCLUSION AND RECOMMENDATIONS

### Conclusion

The impact of air pollution on human health is a matter of great concern and has been extensively studied over the years. The empirical evidence from a multitude of research studies clearly indicates that air pollution significantly affects various aspects of human health, leading to a wide range of adverse health outcomes. One of the most evident and extensively studied effects of air pollution is its association with respiratory diseases. Exposure to pollutants such as particulate matter (PM), nitrogen dioxide (NO<sub>2</sub>), ozone (O<sub>3</sub>), and volatile organic compounds (VOCs) has been linked to an increased risk of respiratory conditions, including asthma, chronic obstructive pulmonary disease (COPD), and respiratory infections. Long-term exposure to high levels of these pollutants is particularly concerning, as it can lead to chronic respiratory issues and exacerbate existing respiratory conditions.

Air pollution has also been found to have significant impacts on cardiovascular health. Numerous studies have shown a strong association between exposure to pollutants and an increased risk of cardiovascular diseases, including heart attacks, strokes, and hypertension. The mechanism behind this link involves the inflammation and oxidative stress caused by air pollutants, leading to the development and progression of cardiovascular disorders. Furthermore, emerging research has shed light on the impact of air pollution on other aspects of human health. Studies have suggested that exposure to air pollution during pregnancy can lead to adverse birth outcomes, such as preterm birth and low birth weight. Moreover, air pollution has been associated with cognitive impairments in children, affecting their academic performance and cognitive development. Additionally, there is growing evidence suggesting a potential link between air pollution and mental health, with prolonged exposure being associated with an increased risk of depression and anxiety.

The consequences of air pollution are not limited to urban centers or industrialized regions. Wildfires and natural disasters can release substantial amounts of harmful pollutants into the air, causing short-term and long-term health impacts on nearby communities. The vulnerability of certain groups, such as children, the elderly, and individuals with pre-existing health conditions, further exacerbates the adverse effects of air pollution. The scientific evidence from empirical studies unequivocally supports the notion that air pollution poses a significant threat to human health. The magnitude of its impact on various health outcomes highlights the urgent need for comprehensive and effective air quality management and pollution control measures. Governments, industries, and individuals must work together to reduce emissions, adopt cleaner technologies, and promote sustainable practices to safeguard human health and ensure a healthier environment for current and future generations. Public awareness and education about the risks of air pollution are crucial in encouraging proactive measures to protect individuals and communities from the detrimental effects of this global health hazard.

### Recommendations

**Stringent Air Quality Standards:** Governments and environmental agencies should set and enforce more stringent air quality standards to limit the concentration of harmful pollutants in the atmosphere. Regular monitoring of air quality, particularly in urban areas and near industrial sites, is essential to ensure compliance and prompt action when pollution levels exceed the acceptable limits. Encouraging the transition from fossil fuels to renewable energy sources, such as solar, wind, and hydroelectric power, can significantly reduce air pollution. Policymakers should offer



incentives and support for the adoption of clean energy technologies to mitigate the emissions from traditional energy sources. Additionally, enhancing public transportation infrastructure and promoting active mobility options, such as walking and cycling, can reduce the reliance on private vehicles and, consequently, vehicular emissions. Investments in efficient and reliable public transport systems can lead to improved air quality in urban areas.

Furthermore, incorporating green spaces and vegetation into urban planning can help mitigate the effects of air pollution. Trees and plants act as natural filters, absorbing pollutants and improving air quality. Urban planners should prioritize the creation and preservation of green spaces to promote healthier living environments. Strict regulations should be implemented to control emissions from industrial facilities. Employing cleaner technologies and enforcing emission reduction measures will minimize the release of harmful pollutants into the air, protecting the health of nearby communities. Public awareness campaigns and educational programs should also be conducted to inform individuals about the health risks associated with air pollution. Raising awareness can empower individuals to take personal actions, such as reducing energy consumption and adopting sustainable practices, to contribute to cleaner air.

Moreover, healthcare systems should be prepared to address the health impacts of air pollution adequately. Healthcare professionals need to be trained to recognize and treat respiratory and cardiovascular conditions related to air pollution exposure. Additionally, governments should allocate sufficient resources to manage the potential increase in healthcare demands due to air pollution-related illnesses. Air pollution is a global issue that requires international cooperation and collaboration. Countries should work together to share best practices, research findings, and technologies for reducing air pollution and improving human health worldwide. Mitigating the impact of air pollution on human health requires a multifaceted approach, involving policy changes, technological advancements, public awareness, and international cooperation. By implementing these well-detailed recommendations, societies can work towards cleaner air and better overall health for their populations.

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