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The Impact of Air Quality Degradation on Respiratory and Cardiovascular Health: A Comprehensive Review of Epidemiological Evidence and Public Health Implications

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Abstract

Background: Air pollution poses significant risks to public health, particularly affecting respiratory and cardiovascular systems. The interplay between environmental factors and human health has garnered increasing attention due to the alarming rates of morbidity and mortality associated with air quality degradation.

Methods: This review synthesizes existing literature on the health impacts of air pollution, focusing on epidemiological studies that assess short- and long-term exposure effects. A comprehensive analysis of pollutants, including particulate matter (PM), nitrogen oxides, and ozone, was conducted, highlighting their sources and health implications.

Results: Findings indicate a strong correlation between air pollution exposure and various health outcomes, including chronic obstructive pulmonary disease (COPD), asthma exacerbation, cardiovascular diseases, and premature mortality. Vulnerable populations, particularly children and the elderly, exhibit heightened sensitivity to air quality variations. Longitudinal studies reveal that prolonged exposure to fine particulate matter significantly increases the risk of developing chronic health conditions and contributes to elevated hospitalization rates.

Conclusion: The evidence underscores the urgent need for effective air quality management strategies and public health interventions to mitigate the adverse health effects of air pollution. Collaborative efforts among policymakers, healthcare professionals, and communities are essential to develop comprehensive policies aimed at reducing pollution levels and protecting public health.

Keywords: air pollution, respiratory health, cardiovascular health, environmental epidemiology, public health intervention.

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1. Introduction

The relationship between people and their physical environment has been thoroughly examined since various human activities impact the ecosystem. The environment comprises the biotic (living beings and

microbes) and the abiotic (hydrosphere, lithosphere, and atmosphere). Pollution is characterized as the introduction of deleterious chemicals into the environment, adversely affecting people and other living species. Pollutants are detrimental solids, liquids, or gasses generated in excessive amounts that degrade environmental quality.

Human activities negatively impact the ecosystem by contaminating the water supply, the air quality, and the soil that sustains plant life. While the Industrial Revolution achieved significant advancements in technology, society, and service supply, it also led to the generation of substantial volumes of pollutants released into the atmosphere, detrimental to human health. Global environmental pollution is unequivocally seen as a worldwide public health concern with several dimensions. Social, economic, and legislative issues, along with lifestyle practices, are associated with this significant problem. Urbanization and industrialization are attaining unprecedented and alarming levels globally in our day. Anthropogenic air pollution is a significant public health threat globally, responsible for around 9 million fatalities annually (1). Undoubtedly, all the above-described factors are intricately linked to climate change, and in the face of peril, the repercussions may be dire for humanity (2). Climate change and the repercussions of global warming significantly impact many ecosystems, resulting in challenges such as food security concerns, the melting of ice and glaciers, species extinction, and harm to vegetation (3, 4).

Air pollution has several health impacts. The health of vulnerable persons might be affected even on days with little air pollution. Brief exposure to air pollution is significantly associated with COPD (Chronic Obstructive Pulmonary Disease), cough, dyspnea, wheezing, asthma, respiratory illnesses, and elevated hospitalization rates (a metric of morbidity). The enduring consequences of air pollution include chronic asthma, pulmonary insufficiency, cardiovascular illnesses, and cardiovascular death (5). Swedish cohort research indicates that long-term exposure to air pollution may promote diabetes. Furthermore, air pollution seems to exert several detrimental health impacts throughout early human development, including respiratory, cardiovascular, mental, and perinatal abnormalities, resulting in infant death or chronic diseases in adulthood (6, 7).

National reports have shown a heightened risk of morbidity and death (1). These investigations were performed globally and demonstrated a link between daily variations in particulate matter (PM) concentration and daily fatality rates. Climate change and global warming may exacerbate the problem. Moreover, heightened hospitalization rates, indicative of morbidity, have been seen in the aged and vulnerable populations for particular causes. Fine and ultrafine particulate matter seems to be linked to more severe health conditions, since it may penetrate the deepest regions of the airways and more readily enter the circulation (8).

Air pollution mostly impacts residents of major metropolitan centers, where vehicular emissions are the primary contributors to air quality deterioration. Industrial accidents pose a risk, since the dissemination of poisonous fog may be lethal to nearby communities. The distribution of contaminants is influenced by several factors, including atmospheric stability and wind (9).

In emerging nations, the issue is exacerbated by overpopulation, unchecked urbanization, and the advancement of industry. This results in subpar air quality, particularly in nations characterized by societal inequalities and little knowledge about sustainable environmental management. The use of wood fuel or solid fuel for household purposes, prompted by low incomes, exposes individuals to poor-quality, contaminated indoor air. It is noteworthy that three billion individuals globally use the aforementioned energy sources for their everyday heating and cooking requirements. In developing nations, women within households seem to bear the greatest risk for illness onset owing to prolonged exposure to indoor air pollution. China, owing to rapid industrialization and overcrowding, is among the Asian nations facing significant air pollution challenges (10, 11). The lung cancer mortality recorded in China is linked to fine particulate matter (12). As previously mentioned, prolonged exposure is linked to harmful effects on the cardiovascular system (3, 5).

It is noteworthy that cardiovascular problems have mostly been documented in industrialized and high-income nations, rather than in emerging low-income countries that are significantly exposed to air

pollution. India has severe air pollution, with air quality reaching dangerous levels. New Delhi is among the most polluted cities in India. Flight operations at New Delhi International Airport often face cancellations owing to diminished visibility resulting from air pollution. Pollution is prevalent in both urban and rural regions of India because to rapid industry, urbanization, and increased motorbike usage (13-15). Nonetheless, biomass combustion related to heating and cooking requirements is a significant contributor to household air pollution in India and Nepal. India exhibits regional variability, as regions with varying climatological circumstances, population densities, and educational levels provide distinct indoor air quality, with higher PM2.5 concentrations recorded in Northern states (557–601 μg/m3) relative to Southern states (183–214 μg/m3) (16, 17). The frigid temperature of North India may primarily account for this, since extended durations spent inside, and more heating are requisite compared to the warm environment of South India. Household air pollution in India is linked to significant health consequences, particularly for women and small children, who spend extended durations inside. Chronic obstructive respiratory disease (CORD) and lung cancer mostly occur in women, while acute lower respiratory illness is primarily found in children under the age of 5 (18, 19).

The accumulation of air pollution, particularly sulfur dioxide and smoking, reaching 1,500 mg/m3, led to an increase in mortality, resulting in 4,000 fatalities in December 1952 in London and 400 deaths in New York City in 1963. A correlation between pollution and mortality was shown by the monitoring of outdoor pollution in six major locations in the United States (20). In all instances, mortality seemed to be more closely associated with the concentrations of fine, inhalable, and sulfate particles than with the levels of total particulate pollution, aerosol acidity, sulfur dioxide, or nitrogen dioxide (20). Additionally, significantly elevated pollution levels have been documented in Mexico City and Rio de Janeiro, followed by Milan, Ankara, Melbourne, Tokyo, and Moscow (19).

Given the significance of the public health effect, it is essential to consider several types of interventions. Reports indicate success and efficacy in local air pollution reduction measures. Appropriate technical measures are implemented, taking into account the origin and characteristics of the emission, together with its effects on health and the environment. Schwela and Köth-Jahr (21) reflect on the significance of controlling point sources and non-point sources of air pollution. An exhaustive emission inventory must document all sources within a specified region. In addition to evaluating the aforementioned sources and their characteristics, terrain and meteorological must also be taken into account, as previously indicated. The evaluation of control policies and procedures is often extended from the local to the regional and subsequently to the global level. Air pollution may be disseminated and conveyed from one place to a distant area. Air pollution management entails the reduction to acceptable levels or potential eradication of air contaminants that adversely impact human health or the natural ecosystem. Private and governmental organizations and agencies undertake measures to guarantee air quality (22).

The WHO and EPA established air quality standards and recommendations for various contaminants as a means of managing air quality (1, 23). These requirements must be evaluated against the emissions inventory standards using causation analysis and dispersion modeling to identify problematic locations (24). Inventories are typically derived from a synthesis of direct observations and emissions models (24). This example illustrates the implementation of control measures at the source using catalytic converters in automobiles. These devices convert pollutants and hazardous gases emitted from combustion engines into less harmful substances via catalysis via redox processes (25). In Greece, the use of private vehicles was limited by the monitoring of their license plates to alleviate traffic congestion at peak hours (25). Regarding industrial emissions, collectors and closed systems can maintain air pollution at the minimum criteria mandated by law (26). Existing initiatives to enhance air quality need an assessment of the economic worth of the benefits derived from planned programs. The planned plans by governmental authorities and directives are provided with guidelines to be adhered to.

In Europe, Air Quality Limit Values (AQLVs) are established for initiating planning claims (27). The NAAQS (National Ambient Air Quality Standards) set the national air quality limit limits in the USA (27). Although regulations and directives operate via distinct mechanisms, significant achievement has been

attained in decreasing total emissions and their related health and environmental impacts (27). The European Directive designates geographical areas of risk exposure as monitoring and assessment zones to document emission sources and air pollution levels, while the USA establishes global air quality criteria based on the severity of air quality issues and catalogs all pollutant sources and their precursors.

Consequently, monies have been supporting, either directly or indirectly, initiatives about air quality and the technological infrastructure necessary for its preservation. These plans emphasize an inventory of databases about air quality environmental planning awareness initiatives. Furthermore, pollution control methods for air emissions may be implemented for automobiles, machinery, and industry in metropolitan environments (28, 29).

Technological innovation can only succeed if it addresses societal requirements. Technology should embody the decision-making processes and protocols of those engaged in risk assessment and evaluation, serving as a facilitator in delivering information and analyses to empower decision-makers to make optimal choices. To formulate an effective air quality control strategy, it is essential to consider several factors: environmental conditions and ambient air quality, engineering aspects and pollutant characteristics, as well as the economic costs associated with technological enhancements and administrative and legal expenses. In light of economic considerations, competitiveness driven by neoliberal principles presents a resolution to environmental issues (22).

The advancement of environmental governance, along with technical progress, has prompted the initiation of a discourse. Environmental politics has engendered dissent and conflict among various political parties, scientists, media entities, and governmental and non-governmental groups. Radical environmental activism initiatives and movements have been established (22). The emergence of new information and communication technologies (ICTs) is often analyzed about its impact on communication methods and social movements, including activism (28). Since the 1990s, the phrase "digital activism" has been used more often across several fields. Currently, several digital technologies may be used to achieve outcomes in digital activism concerning environmental concerns. Devices having online capabilities, such as computers and mobile phones, are used to effect change in political and social matters (30).

This study examines the origins of environmental pollution concerning public health and proposes remedies and interventions relevant to environmental lawmakers and decision-makers.

2. Origins of Exposure

The bulk of environmental contaminants are released by extensive human activities, including industrial machines, electricity generation facilities, combustion engines, and automobiles. Due to their extensive execution, these activities are the predominant sources of air pollution, with automobiles estimated to account for around 80% of current pollution levels (31). Additional human activities, including agricultural practices, petrol stations, fuel tank heaters, and cleaning methods, are also impacting our environment to a lesser degree, alongside various natural causes such as volcanic eruptions, soil disturbances, and wildfires. The categorization of air pollutants mostly relies on the sources generating pollution. Consequently, it is important to highlight the four primary sources according to the categorization system: Major sources, Area sources, Mobile sources, and Natural sources (32).

Primary sources include pollution emissions from power plants, refineries, petrochemical facilities, the chemical and fertilizer sectors, metallurgical and other industrial establishments, as well as municipal incineration. Indoor area sources include household cleaning tasks, dry cleaning establishments, printing facilities, and gas stations. Mobile sources include autos, cars, railroads, aircraft, and several other vehicles. Ultimately, natural sources include, as previously said, physical calamities (33) including wildfires, volcanic erosion, dust storms, and agricultural burning. Nonetheless, other categorization schemes have been suggested.

Air pollution is defined as the sustained presence of contaminants in the atmosphere at significant concentrations. Air pollutants include scattered particles, hydrocarbons, carbon monoxide, carbon dioxide, nitrogen monoxide, nitrogen dioxide, and sulfur trioxide, among others. Water pollution encompasses

organic and inorganic contaminants, as well as biological agents, at elevated concentrations that compromise water quality. Soil contamination transpires due to the discharge of chemicals or the disposal of waste materials, including heavy metals, hydrocarbons, and pesticides (34-36). Air pollution may adversely affect soil and water quality by contaminating precipitation that subsequently enters these habitats. Acid precipitation may significantly alter soil chemistry, impacting vegetation, crops, and water quality (37). Furthermore, the mobility of heavy metals is enhanced by soil acidity, resulting in their transfer into aquatic environments. Heavy metals, like aluminum, are detrimental to animals and fish. Soil quality is significant since soils with low calcium carbonate concentrations are more vulnerable to acid rain. In addition to precipitation, rain, snow, and particle debris infiltrate aquatic bodies (36, 38). Finally, pollution is categorized by its origin into radioactive and nuclear pollution, which introduces radioactive and nuclear contaminants into water, air, and soil due to nuclear explosions, accidents, the use of nuclear weapons, and the management or disposal of radioactive waste.

Radioactive substances may pollute surface water bodies and are detrimental to the environment, flora, fauna, and people. Several radioactive chemicals, including radium and uranium, accumulate in bones and may induce cancer. Noise pollution is generated by machinery, automobiles, traffic sounds, and musical installations that are detrimental to our auditory health. The World Health Organization coined the term DALYs. Disability-adjusted life Years (DALYs) for an illness or health condition are defined as the aggregate of Years of Life Lost (YLL) owing to premature mortality across the community and Years Lost due to Disability (YLD) for individuals affected by the health condition or its repercussions (39). In Europe, air pollution is the primary contributor to disability-adjusted life years lost (DALYs), followed by noise pollution. The associations between noise and air pollution and health have been investigated (40). The research indicated that disability-adjusted life years (DALYs) associated with noise were more significant than those linked to air pollution since the impact of ambient noise on cardiovascular disease was independent of air pollution (40). Environmental noise needs to be regarded as a distinct public health hazard (40).

Environmental pollution transpires when alterations in the physical, chemical, or biological components of the environment (such as air masses, temperature, and climate) are generated. Pollutants adversely affect our environment by elevating levels above typical thresholds or by adding deleterious poisonous compounds. main pollutants are directly generated from the aforementioned sources, whereas secondary pollutants are released as by-products of the main pollutants. Pollutants may be biodegradable or non-biodegradable and may originate from natural sources or human activities, as previously mentioned. Furthermore, their origin may be a distinct source (point-source) or distributed source.

Pollutants exhibit variations in physical and chemical characteristics, elucidating the disparities in their potential to induce hazardous consequences. Aerosol compounds (41–43) exhibit higher toxicity than gaseous compounds owing to their diminutive size (solid or liquid) in the atmosphere, which enhances their penetrating capability. Gaseous substances are more readily expelled by our respiratory system (41). These particles may harm the lungs and may infiltrate the bloodstream, resulting in the untimely deaths of millions annually. Furthermore, aerosol acidity ([H+]) seems to significantly augment the formation of secondary organic aerosols (SOA), but this assertion lacks corroboration from other research groups (38).

3. Impact of Air Pollution on Health

The predominant air pollutants are ground-level ozone and particulate matter (PM). Individuals exposed to elevated levels of air pollution exhibit signs of illness with varying degrees of severity. The consequences are categorized into short-term and long-term health impacts. Vulnerable groups that must be cognizant of health protection measures include the elderly, children, and those with diabetes or pre-existing cardiovascular or pulmonary conditions, particularly asthma.

As previously emphasized, recent epidemiological research from Harvard School of Public Health indicates that the relative magnitudes of short- and long-term impacts remain inadequately elucidated (45) owing to varying epidemiological methodology and exposure inaccuracies. New models are suggested for more effectively evaluating short- and long-term human exposure data (45). In this part, we highlight the

prevalent short- and long-term health impacts, along with general concerns for both categories, since these effects often rely on environmental circumstances, dosage, and individual sensitivity. Short-term effects are transient and include mild discomfort, including eye, nose, skin, and throat irritation, wheezing, coughing, chest tightness, and respiratory difficulties, as well as more severe conditions such as asthma, pneumonia, bronchitis, and cardiovascular and pulmonary issues. Acute exposure to air pollution may induce headaches, nausea, and dizziness.

Prolonged exposure to pollutants may exacerbate these issues, adversely affecting the neurological, reproductive, and respiratory systems, and perhaps leading to cancer and, in rare instances, fatalities. The long-term consequences are chronic, persisting for years or a lifetime, and may ultimately result in death. Moreover, the toxicity of many air contaminants may potentially lead to the development of several malignancies over time (46).

Respiratory illnesses are intimately linked to the intake of air pollution. These contaminants will infiltrate the airways and collect inside the cells. The damage to target cells must correlate with the specific pollutant component, its origin, and the dosage administered. The health impacts are significantly influenced by the nation, region, season, and time. A prolonged exposure to the pollutant is likely to result in long-term health problems associated with the aforementioned conditions.

Particulate Matter (PMs), dust, benzene, and ozone (O3) inflict significant harm on the respiratory system. Additionally, there exists an increased risk in the presence of pre-existing respiratory conditions, such as asthma (47). Long-term impacts are more prevalent in those with a predisposed medical condition. Voice changes may be seen after acute exposure to contaminants that pollute the trachea. Chronic obstructive pulmonary disease (COPD) may be precipitated by air pollution, resulting in heightened morbidity and mortality (48). The primary contributors to COPD risk include prolonged exposure to traffic, industrial air pollution, and fuel combustion.

Numerous cardiovascular consequences have been noted after exposure to air pollution (49). Prolonged exposure may induce alterations in blood cells that might impact heart function. Coronary arteriosclerosis has been documented after prolonged exposure to traffic emissions, while short-term exposure is associated with hypertension, stroke, myocardial infarctions, and heart failure. Ventricular hypertrophy is shown to develop in humans with prolonged exposure to nitrogen dioxide (NO2) (50). Neurological consequences have been seen in both adults and children after prolonged exposure to air pollution. Long-term air pollution seems to be associated with psychological difficulties, autism, retinopathy, fetal development issues, and low birth weight (51). The etiology of neurodegenerative disorders, such as Alzheimer's and Parkinson's, remains unidentified; nevertheless, prolonged exposure to air pollution is considered a contributing factor. Pesticides and metals are specifically identified as etiological variables, alongside nutrition. The processes underlying the progression of neurodegenerative diseases include oxidative stress, protein aggregation, inflammation, and mitochondrial dysfunction in neurons (52) (Figure 1).

Figure 1. Effects of air pollutants on health.

Canine brain inflammation was detected in dogs residing in a severely polluted region of Mexico for an extended duration (53). In adult humans, indicators of systemic inflammation (IL-6 and fibrinogen) were seen to elevate as an early reaction to PNC about IL-6 levels, perhaps resulting in the synthesis of acute-phase proteins (54). The advancement of atherosclerosis and oxidative stress seem to be the processes implicated in the neurological impairments induced by prolonged exposure to air pollution. Inflammation is a consequence of oxidative stress and seems to contribute to the disruption of embryonic maturation, impacting several organs (55). Likewise, several elements seem to contribute to developmental maturation, which delineates susceptibility to prolonged air pollution exposure. Factors include birthweight, mother smoking, genetic predisposition, socioeconomic status, and educational attainment.

Nonetheless, food, beginning with breastfeeding, is another determining element. The diet serves as the primary source of antioxidants, which are essential for our defense against air pollution (56).

Antioxidants operate as free radical scavengers, mitigating the interaction of free radicals in the brain (56). Likewise, genetic background may lead to varying vulnerability to the oxidative stress pathway (57). Antioxidant therapy with vitamins C and E seems to influence the impact of ozone in asthmatic children who are homozygous for the GSTM1 null gene (58). Inflammatory cytokines secreted in the periphery, such as those from respiratory epithelia, enhance the expression of the innate immunological Toll-like receptor 2. Recent observations indicate that such activation and the ensuing neurodegenerative processes have been seen in lung lavage from mice exposed to ambient particulate matter in Los Angeles, California (USA) (58). Neurodevelopmental morbidities were reported in children after lead exposure. These youngsters exhibited aggressive and delinquent conduct, diminished IQ, learning challenges, and hyperactivity (59). No degree of lead exposure seems to be "safe," and the scientific community has urged the Centers for Disease Control and Prevention (CDC) to lower the existing screening standard of 10 μg/dl (60).

The influence on the immune system, resulting in dysfunction and neuroinflammation (104), is associated with poor air quality. However, elevations in serum concentrations of immunoglobulins (IgA, IgM) and the complement component C3 are seen (60). Additionally, antigen presentation is influenced by air pollution, resulting in the overexpression of costimulatory molecules such CD80 and CD86 on macrophages (61). Skin serves as our barrier against ultraviolet radiation (UVR) and other contaminants, being the outermost layer of our body. Traffic-related contaminants, including PAHs, VOCs, oxides, and PM, may induce pigmented lesions on the skin (62). As previously mentioned, the infiltration of pollutants via the skin or by inhalation results in organ damage, since some pollutants possess mutagenic and carcinogenic properties, particularly impacting the liver and lungs. Conversely, air pollutants, particularly those in the troposphere, mitigate the detrimental effects of ultraviolet radiation (UVR) in polluted metropolitan environments (62). Airborne pollutants absorbed by human skin may exacerbate skin aging, psoriasis, acne, urticaria, eczema, and atopic dermatitis, often resulting from exposure to oxides and photochemical smog. Exposure to particulate matter and cigarette smoking serve as agents of skin aging, resulting in spots, dyschromia, and wrinkles. Finally, contaminants have been linked to skin cancer (62).

Increased morbidity is found in fetuses and children exposed to the aforementioned hazards. Impairment in prenatal development, reduced birth weight, and autism have been shown (63). The eye is another external organ that may be impacted. Contamination often originates from suspended contaminants and may lead to asymptomatic ocular effects, irritation, retinopathy, or dry eye syndrome (64-66).

4. Summary

Undoubtedly, technology advancements facilitate our lives, and although it seems challenging to mitigate the detrimental effects of gas emissions, we may limit their use by pursuing dependable strategies. A worldwide preventative strategy should be developed to address anthropogenic air pollution, complementing the effective management of its detrimental health impacts. Sustainable development techniques must be used with research-derived knowledge to address the issue successfully. At this juncture, global collaboration regarding research, development, policy administration, oversight, and governance is essential for successful pollution management. Legislation regarding air pollution must be synchronized and revised, and policymakers should advocate for the development of a robust instrument for environmental and health safeguarding. This article primarily advocates for the cultivation of local frameworks to enhance experience and practice, then extending these initiatives to the international sphere by formulating effective regulations for sustainable ecosystem management.

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تأثير تدهور جودة الهواء على صحة الجهاز التنفسي والقلب والأوعية الدموية: مراجعة شاملة للأدلة الوبائية وآثارها على الصحة العامة

الملخص

الخلفية :يشكل تلوث الهواء مخاطر كبيرة على الصحة العامة، حيث يؤثر بشكل خاص على أنظمة التنفس والقلب والأوعية الدموية. لقد حظيت العلاقة بين العوامل البيئية وصحة الإنسان باهتمام متزايد بسبب المعدلات المقلقة من المراضة والوفيات المرتبطة بتدهور جودة الهواء.

الطرق :تقوم هذه المراجعة بتلخيص الأدبيات الموجودة حول تأثيرات الصحة لتلوث الهواء، مع التركيز على الدراسات الوبائية التي تقيم آثار التعرض على المدى القصير والطويل. تم إجراء تحليل شامل للملوثات، بما في ذلك الجسيمات الدقيقة (PM) وأكاسيد النيتروجين والأوزون، مع تسليط الضوء على مصادرها وآثارها الصحية.

النتائج :تشير النتائج إلى وجود علاقة قوية بين التعرض لتلوث الهواء ومجموعة متنوعة من النتائج الصحية، بما في ذلك مرض الانسداد الرئوي المزمن(COPD) ، وتفاقم الربو، وأمراض القلب والأوعية الدموية، والوفيات المبكرة. تظهر الفئات الضعيفة، وخاصة الأطفال وكبار السن، زيادة في الحساسية لتغيرات جودة الهواء. تكشف الدراسات الطولية أن التعرض المطول للجسيمات الدقيقة يزيد بشكل كبير من خطر تطور حالات الصحة المزمنة ويساهم في ارتفاع معدلات الاستشفاء.

الخاتمة :تؤكد الأدلة على الحاجة الملحة لاستراتيجيات إدارة جودة الهواء الفعالة والتدخلات الصحية العامة لتخفيف الآثار الصحية الضارة لتلوث الهواء. إن التعاون بين صانعي السياسات، والمهنيين الصحيين، والمجتمعات أمر ضروري لتطوير سياسات شاملة تهدف إلى تخفيض مستويات التلوث وحماية الصحة العامة.

الكلمات المفتاحية :تلوث الهواء، صحة الجهاز التنفسي، صحة القلب والأوعية الدموية، الوبائيات البيئية، تدخل الصحة العامة.