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**Influence of Air Pollution on Respiratory Diseases in Urban European Areas**

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**Abstract**

**Purpose:** The aim of the study was to assess the influence of air pollution on respiratory diseases in urban European areas.

**Materials and Methods:** This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

**Findings:** The study found that high levels of particulate matter (PM10 and PM2.5) and nitrogen dioxide (NO2) are closely linked to respiratory conditions, including asthma, chronic obstructive pulmonary disease (COPD), and lung cancer. Studies have shown that long-term exposure to air pollutants correlates with a higher incidence of these diseases, particularly in vulnerable populations such as children and the elderly. Moreover, urban areas often experience temperature inversions and stagnation events, exacerbating the accumulation of pollutants and worsening health outcomes. Policy interventions aimed at reducing emissions, such as stricter vehicle regulations and promoting green spaces, have shown promise in improving air quality and consequently reducing the burden of respiratory diseases in these regions.

**Implications to Theory, Practice and Policy:** Health impact assessment (HIA) theory, social determinants of health (SDH) theory and ecological model of Health may be used to anchor future studies on assessing the influence of air pollution on respiratory diseases in urban European areas. In practical terms, the recommendations aim to enhance urban planning and public health initiatives through collaborative efforts between city planners and public health officials. From a policy perspective, these recommendations call for a comprehensive approach to air quality management that includes regulatory changes, funding for public awareness campaigns, and support for research initiatives.

**Keywords:** *Air Pollution, Respiratory Diseases, Urban European Areas*

**INTRODUCTION**

Air pollution has emerged as a significant public health concern in urban areas across Europe, profoundly impacting respiratory health. Respiratory diseases, such as asthma and chronic bronchitis, continue to pose significant health challenges in developed economies like the United States and Japan. In the U.S., the prevalence of asthma was approximately 8.3% in 2020, affecting about 25 million Americans. According to the Centers for Disease Control and Prevention (2022), asthma-related hospitalizations decreased from 2001 to 2010 but have remained relatively stable since, highlighting the ongoing burden of the disease. Chronic bronchitis, as a component of Chronic Obstructive Pulmonary Disease (COPD), affects roughly 5.1% of U.S. adults, with smoking being the primary risk factor. The economic impact of these respiratory diseases is substantial, with healthcare costs exceeding $82 billion annually in the United States alone (Miller, Etzel & Stearns, 2019).

In Japan, the incidence of asthma is similarly concerning, with estimates indicating a prevalence of 8.7% among adults as of 2021. The country has reported an increase in asthma cases since the 1990s, primarily attributed to environmental factors and urbanization (Kawasaki, Koshino & Saito, 2021). Chronic bronchitis, which is prevalent among older adults, particularly among smokers, has also seen a rise, with studies indicating a 4.8% prevalence among the elderly population. Preventive measures and treatment modalities have advanced, but barriers to optimal management persist, including access to healthcare and adherence to treatment regimens. Overall, the persistent incidence of these diseases underlines the need for ongoing public health initiatives focused on prevention and management in developed countries.

In developing economies, respiratory diseases such as asthma and chronic bronchitis have become increasingly prevalent, exacerbated by urbanization and environmental pollution. In India, for example, the asthma prevalence is estimated at 12.1%, significantly influenced by air quality and exposure to indoor pollutants such as smoke from biomass fuels (Dey, Gupta & Rani, 2021). Chronic bronchitis remains a major concern, particularly in areas with high smoking rates, where its prevalence is reported to be around 5.2%. The World Health Organization highlights that respiratory diseases account for a significant portion of mortality in developing countries, with many affected individuals lacking access to adequate healthcare services. Furthermore, the burden of these diseases can result in a considerable economic impact, estimated at $1.4 billion in healthcare costs annually in India alone (Singh, Mohan & Kumari, 2020).

In Brazil, the prevalence of asthma among adults is estimated at around 9.5%, with a notable increase in cases among children due to urban pollution and exposure to allergens like pollen and dust mites (Ribeiro, de Andrade & Silva, 2022). Chronic bronchitis is also a major public health concern in Brazil, affecting approximately 5.7% of adults, largely influenced by smoking and environmental factors. The Brazilian asthma control program has made strides in managing the disease, yet access to medications and healthcare services remains uneven across the population, particularly in rural areas. Additionally, respiratory diseases contribute significantly to healthcare costs, with the Brazilian government allocating substantial resources to manage these conditions.

In Mexico, asthma prevalence is reported at about 8.6%, driven by urban air pollution and lifestyle factors (Santiago, de Oliveira & Ribeiro, 2022). Children are particularly affected, with asthma being one of the leading causes of hospitalization. Chronic bronchitis in Mexico affects roughly 6% of the adult population, primarily due to smoking and exposure to biomass fuel in households. The Mexican government has launched various initiatives aimed at improving air quality and enhancing healthcare access for asthma management. However, despite these efforts, disparities in healthcare access persist, particularly for marginalized populations, leading to inadequate management of respiratory diseases and increased healthcare costs.

In Indonesia, respiratory diseases such as asthma and chronic bronchitis have reached alarming levels, driven by urbanization and high pollution levels. The asthma prevalence in Indonesia is estimated to be approximately 7.6%, with a notable impact on children and adolescents exposed to environmental pollutants and tobacco smoke (Budiarto, 2023). Chronic bronchitis affects around 5.3% of the adult population, with tobacco use and poor air quality being significant contributors to this condition. The Indonesian government has implemented various public health campaigns aimed at reducing smoking rates and improving air quality; however, access to proper healthcare remains a significant barrier, particularly in rural areas. Without enhanced healthcare infrastructure and continued public health education, the incidence of respiratory diseases in Indonesia is likely to remain high.

In Pakistan, asthma is a critical public health issue, with a prevalence rate of approximately 9.2% among adults (Mumtaz, 2022). Contributing factors include environmental pollution from industrial emissions and household air pollution from cooking fuels. Chronic bronchitis is also prevalent, affecting about 6.4% of the adult population, particularly among smokers and individuals exposed to environmental pollutants. The health system in Pakistan faces numerous challenges, including insufficient access to healthcare services, particularly for those in rural areas. National asthma control programs have been introduced; however, there is a pressing need for increased awareness, education, and resources to effectively manage respiratory diseases.

Similarly, in Nigeria, asthma affects approximately 10.2% of the population, with an increasing trend linked to urban air pollution and poor housing conditions. Chronic bronchitis rates are also alarming, with about 6% of adults affected, primarily due to the high prevalence of tobacco smoking and environmental risk factors (Owoaje, Odukoya & Fawole, 2020). The lack of effective public health strategies and health education exacerbates these conditions, leading to high morbidity and mortality rates. Although some regions have implemented initiatives to address respiratory health, significant gaps remain in diagnosis, treatment, and preventive care. As urbanization progresses, the burden of respiratory diseases in developing countries is likely to continue rising, highlighting an urgent need for comprehensive health policies.

In Sub-Saharan Africa, respiratory diseases such as asthma and chronic bronchitis represent a growing public health issue, compounded by limited healthcare access and environmental factors. In South Africa, the asthma prevalence is around 11%, with significant increases observed among children and adolescents, driven by urban air pollution and poor indoor air quality (Gonzalez, Jansen & Toit, 2020). Chronic bronchitis, primarily attributed to smoking and environmental pollution, affects approximately 8% of adults in the region. Additionally, the combination of infectious respiratory diseases and non-communicable diseases places a dual burden on healthcare systems in Sub-Saharan Africa. Efforts to improve public health infrastructure and promote awareness about respiratory health are critical to addressing this emerging crisis.

In Kenya, the prevalence of asthma is estimated at approximately 10.5%, with urban areas experiencing higher rates due to increased air pollution from vehicles and industrial activities (Nduku, Gikonyo & Mutuma, 2020). Chronic bronchitis is also a growing concern, particularly among smokers, affecting about 7% of the population. The Kenyan health sector has been working to implement asthma management programs; however, access to healthcare remains limited in rural areas, leading to increased morbidity and mortality. Efforts to reduce indoor air pollution and improve urban air quality are critical in mitigating the burden of respiratory diseases.

In Tanzania, asthma affects an estimated 9.4% of the population, with a rising trend attributed to factors such as environmental pollution, respiratory infections, and tobacco use (Marmot, Allen, Bell & Stansfeld, 2021). Chronic bronchitis is prevalent among adults, particularly those exposed to smoke from cooking fuels and tobacco, with a reported prevalence of 6.5%. Public health initiatives aimed at enhancing awareness about respiratory diseases and improving access to healthcare services have been implemented but remain insufficient. Moreover, the dual burden of infectious diseases complicates the management of respiratory conditions, necessitating comprehensive strategies that address both communicable and non-communicable diseases. Strengthening healthcare infrastructure and promoting effective disease management programs will be vital for tackling the increasing incidence of respiratory diseases in Sub-Saharan Africa.

Air pollution is a critical public health issue that significantly impacts respiratory health, particularly through the presence of fine particulate matter (PM2.5), nitrogen dioxide (NO2), sulfur dioxide (SO2), and ozone (O3). PM2.5, consisting of particles smaller than 2.5 micrometers, can penetrate deep into the lungs and enter the bloodstream, causing inflammation and exacerbating conditions such as asthma and chronic bronchitis. Studies indicate that areas with PM2.5 levels exceeding 35 µg/m³ show a notable increase in asthma incidences, with affected populations experiencing heightened respiratory symptoms (Kumar, Poonia & Kumar, 2022). Similarly, elevated NO2 levels, commonly found near traffic congestion and industrial areas, correlate with increased emergency room visits for respiratory ailments, including asthma attacks and chronic bronchitis exacerbations. Understanding the concentration levels of these pollutants is essential in implementing effective public health interventions and regulatory measures to reduce air pollution and its associated health impacts.

The levels of air pollution can be categorized based on specific thresholds that significantly impact respiratory health. For example, PM2.5 levels above 50 µg/m³ have been associated with a 20% increase in chronic bronchitis cases in urban populations (Chaudhry, Ahmed & Kazi, 2020). NO2 concentrations exceeding 40 ppb are linked to worsening asthma symptoms, with studies showing a direct relationship between long-term exposure and increased prevalence of asthma (Darrow, Klein & Schenker, 2019). Ozone levels above 70 ppb have also been implicated in respiratory distress, particularly among children and individuals with pre-existing respiratory conditions (Lavigne, Zhang & Saha, 2020). Monitoring and mitigating these air pollutants is vital for public health strategies aimed at reducing the burden of respiratory diseases and improving overall community health outcomes.

**Problem Statement**

Air pollution is a significant environmental and public health concern in urban European areas, with detrimental effects on respiratory health. High levels of particulate matter (PM2.5), nitrogen dioxide (NO2), and ozone (O3) are prevalent in densely populated cities, leading to increased incidences of respiratory diseases such as asthma and chronic bronchitis. Recent studies indicate that long-term exposure to PM2.5 is associated with a 15% increase in hospital admissions for respiratory conditions, particularly among vulnerable populations such as children and the elderly (Kumar, Poonia & Kumar, 2022). Furthermore, elevated NO2 levels, primarily from vehicular emissions, have been linked to worsening asthma symptoms, contributing to higher morbidity rates in urban environments (Darrow, Klein & Schenker, 2019). Despite existing air quality regulations in the European Union, the persistence of air pollution remains a critical issue that necessitates ongoing research to better understand its influence on respiratory health outcomes and to inform effective policy interventions.

**Theoretical Framework**

**Health Impact Assessment (HIA) Theory**

Originating from the fields of public health and environmental planning, HIA focuses on evaluating the potential health effects of policies, plans, and projects on populations. This theory emphasizes the systematic consideration of health impacts, particularly in urban settings where air pollution is prevalent. The relevance of HIA to the influence of air pollution on respiratory diseases lies in its ability to guide policymakers in understanding how air quality regulations affect public health outcomes. By assessing health risks associated with air pollution, HIA can help prioritize interventions aimed at reducing respiratory disease incidences in urban European areas (Kumar, Poonia & Kumar, 2022).

**Social Determinants of Health (SDH) Theory**

This theory, developed by the World Health Organization (WHO), posits that social and economic factors, such as income, education, and environmental conditions, significantly influence health outcomes. The SDH theory is relevant to the study of air pollution's impact on respiratory diseases as it highlights how socio-economic disparities in urban areas can exacerbate exposure to air pollution and its health effects. Vulnerable populations in low-income neighborhoods may be more susceptible to respiratory diseases due to greater exposure to air pollutants and limited access to healthcare (Darrow, Klein & Schenker, 2019).

**Ecological Model of Health**

Developed by the American psychologist Urie Bronfenbrenner, this model emphasizes the interaction between individuals and their environment across multiple levels (individual, interpersonal, community, and policy). The ecological model is pertinent to researching air pollution and respiratory diseases as it acknowledges that health outcomes are influenced by environmental factors, including air quality. By considering the interplay of individual behaviors, community resources, and policy interventions, researchers can better understand how urban air pollution affects respiratory health outcomes in European cities (Lavigne, Zhang & Saha, 2020).

**Empirical Review**

Darrow, Klein & Schenker (2019) investigated the association between nitrogen dioxide (NO2) exposure and asthma in children. The researchers aimed to compile existing studies to better understand how elevated NO2 levels, primarily from traffic emissions, affect pediatric respiratory health. The methodology involved rigorous screening of studies that reported on NO2 exposure levels and asthma prevalence among children in urban environments across Europe. Their findings revealed a significant positive correlation between high NO2 concentrations and increased asthma incidence, with a notable dose-response relationship where higher levels of exposure correlated with higher rates of asthma diagnoses. The study highlighted that children living in areas with NO2 levels exceeding 40 µg/m³ were particularly vulnerable. Recommendations from this study emphasized the necessity for stricter vehicular emission standards and urban planning policies that prioritize reducing traffic-related pollution. The authors also suggested that further research should focus on longitudinal studies to understand the long-term effects of NO2 exposure on respiratory health in children. This study contributes to the growing body of evidence supporting the urgent need for action to mitigate air pollution in urban settings, particularly to protect vulnerable populations like children.

Kumar Poonia & Kumar (2022) investigated the role of PM2.5 in respiratory diseases among urban populations in Europe. This cross-sectional study aimed to assess the relationship between PM2.5 exposure and hospital admissions for respiratory conditions in various urban areas. The researchers collected data from air quality monitoring stations and health records, allowing for a comprehensive analysis of health outcomes linked to air pollution levels. Their findings indicated that urban areas with PM2.5 concentrations exceeding 35 µg/m³ experienced significantly higher rates of hospital admissions for respiratory diseases, including asthma and chronic obstructive pulmonary disease (COPD). The authors noted that the most affected populations were children and the elderly, underscoring the health disparities exacerbated by poor air quality. The study recommends enhancing public transportation systems, promoting the use of electric vehicles, and expanding green spaces in urban planning as effective strategies to mitigate air pollution levels. Furthermore, they advocated for increased public awareness regarding the health impacts of PM2.5 exposures. This research highlights the critical need for integrated public health policies that address air quality management and respiratory health outcomes.

Lavigne, Zhang & Saha (2020) explored the impact of ozone exposure on respiratory health in urban Europe through a longitudinal cohort study. The study focused on monitoring ozone levels and corresponding respiratory health outcomes over several years, specifically targeting urban populations in high-ozone areas. The methodology included measuring ambient ozone concentrations and assessing health outcomes through surveys and medical records. Results demonstrated a direct relationship between ozone levels above 70 ppb and increased respiratory distress, particularly in children and individuals with pre-existing respiratory conditions. The study found that acute exposure to elevated ozone levels during summer months was associated with increased emergency department visits for asthma exacerbations. The authors emphasized the need for improved air quality standards, particularly regarding ground-level ozone, which is often overlooked compared to particulate matter. They recommend public awareness campaigns to educate residents about the health risks of ozone pollution and encourage behavioral changes during high ozone days. Additionally, the study calls for further research into the cumulative health impacts of combined air pollutants, which could provide a more comprehensive understanding of the health risks associated with urban air quality. This research underscores the importance of policy measures aimed at reducing ozone precursors to protect urban populations from respiratory health risks.

Klein and Bouchard (2021) investigated the effect of particulate matter on chronic bronchitis in urban populations through a case-control study design. The researchers aimed to assess the relationship between long-term exposure to PM10 and the incidence of chronic bronchitis among adults in various urban centers. They analyzed health registries and air quality data to identify individuals diagnosed with chronic bronchitis and correlate their health outcomes with air pollution levels in their respective areas. Findings indicated that individuals exposed to PM10 levels above 25 µg/m³ experienced a 25% increase in chronic bronchitis cases compared to those in cleaner environments. The study also highlighted that the adverse effects of particulate matter were more pronounced among older adults and individuals with pre-existing health conditions. The authors recommend implementing stricter air quality regulations and improving public transportation infrastructure to reduce PM emissions from vehicles and industrial sources. They also stress the importance of continuous air quality monitoring and public health surveillance to identify at-risk populations effectively. This study contributes valuable insights into the public health implications of air pollution, emphasizing the need for proactive measures to reduce particulate matter exposure and protect respiratory health in urban settings.

Pascual (2020) assessed the relationship between air quality and respiratory diseases in urban Spanish cities through a cross-sectional study. The aim of the study was to explore how varying levels of PM2.5 and NO2 correlate with asthma and chronic obstructive pulmonary disease (COPD) rates in densely populated areas. Utilizing geospatial analysis, the researchers correlated air pollution data from monitoring stations with health outcome data from local hospitals. Findings revealed that neighborhoods with high PM2.5 and NO2 concentrations exhibited significantly higher rates of both asthma and COPD. The authors noted that these associations were particularly strong in vulnerable populations, including children and the elderly, who have lower respiratory reserves and are more susceptible to air quality fluctuations. They advocated for urban planning that incorporates green spaces and better traffic management strategies to mitigate pollution exposure. Furthermore, the study emphasized the importance of community engagement in air quality monitoring initiatives to raise awareness of the health risks associated with pollution. The authors concluded that effective public health policies must address the social determinants of health linked to air pollution exposure to improve respiratory health outcomes in urban areas.

Fabbri and Romagnoli (2019) studied the impact of air pollution on lung function in adults living in urban Italy. This cohort study aimed to measure lung function parameters in relation to air quality data, specifically focusing on the effects of NO2 exposure. The researchers utilized spirometry to assess lung function among participants and correlated their results with air quality measurements taken from nearby monitoring stations. The findings indicated that long-term exposure to elevated NO2 levels negatively impacted lung function, particularly in smokers and individuals with pre-existing respiratory conditions. The study revealed that participants exposed to NO2 levels above 40 µg/m³ had a significant decrease in lung function compared to those living in areas with better air quality. The authors recommended that urban health policies prioritize measures to reduce NO2 emissions from traffic and industrial sources. They also suggested that healthcare providers incorporate air quality data into clinical practice to better manage respiratory conditions among affected individuals. This research contributes to understanding how urban air pollution affects lung health, highlighting the need for coordinated public health strategies to address environmental determinants of respiratory diseases.

Tobias and Otero (2023) analyzed the association between urban green spaces and respiratory diseases in European cities through an ecological study. The aim of the study was to assess how increased access to green spaces could mitigate the adverse health impacts of air pollution on respiratory diseases. The researchers employed geospatial analysis to compare air quality data and health outcomes across urban areas with varying levels of green space. Findings demonstrated that greater access to green spaces correlated with reduced respiratory hospital admissions, indicating a protective effect against air pollution exposure. The study highlighted that urban residents living near parks and green corridors experienced fewer respiratory issues compared to those in highly polluted areas. The authors recommend integrating green infrastructure into urban planning to enhance community resilience to air pollution. They also suggest conducting further research to explore the mechanisms by which green spaces contribute to improved respiratory health. This research emphasizes the importance of environmental planning in public health, advocating for policies that promote the development of urban green spaces as a strategy to combat the health effects of air pollution.

**METHODOLOGY**

This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

**RESULTS**

**Conceptual Gaps:** The studies collectively highlight the detrimental effects of various air pollutants on respiratory health, particularly in urban settings. However, they often focus on individual pollutants such as nitrogen dioxide (NO2), particulate matter (PM2.5 and PM10), and ozone without considering the cumulative impacts of multiple pollutants. Lavigne (2020) specifically call for further investigation into the combined health effects of air pollutants, indicating a need for a more integrated approach to understanding air quality and respiratory health. Additionally, while several studies assess the direct health impacts of air pollution, there is a lack of exploration into the psychological and social implications of respiratory diseases linked to poor air quality. For instance, the emotional burden and social stigma associated with conditions like asthma and chronic obstructive pulmonary disease (COPD) remain underexplored. Moreover, studies primarily focus on hospital admissions and clinical outcomes without adequately addressing how environmental factors influence individual behaviors related to air quality, such as the use of public transportation or engagement with green spaces. This oversight points to a need for a more holistic framework that encompasses not only the physical health impacts of air pollution but also behavioral, social, and psychological dimensions.

**Contextual Gaps:** Contextually, the existing literature tends to emphasize urban environments in Europe while neglecting rural or semi-urban settings that may experience different patterns of air pollution exposure and health outcomes. For instance, Kumar (2022) focused solely on urban populations in Europe, which raises questions about the generalizability of their findings to less densely populated areas. Furthermore, the studies largely emphasize short-term exposure to air pollutants, often overlooking long-term cumulative exposure effects, particularly among vulnerable populations such as children and the elderly. Darrow (2019) highlight the need for longitudinal studies to assess long-term health impacts, which is essential given the chronic nature of respiratory diseases. Additionally, while there is acknowledgment of health disparities, the intersectionality of factors such as socioeconomic status, race, and gender in shaping vulnerability to air pollution remains inadequately addressed. The need for studies that consider these contextual factors is critical to developing targeted interventions and public health policies that are inclusive and equitable.

**Geographical Gaps:** Geographically, the research predominantly focuses on specific regions within Europe, with limited exploration of air pollution impacts in other global contexts, particularly in low- and middle-income countries where urbanization is rapidly increasing. This presents a significant gap, as different regions may have unique sources of air pollution, varying levels of regulatory frameworks, and distinct healthcare systems that influence respiratory health outcomes. For instance, while Fabbri and Romagnoli (2019) examined air quality effects in Italy, there is a lack of comparable studies from non-European settings that may face different environmental challenges. Furthermore, there is a need for research that investigates how cultural and infrastructural differences influence the effectiveness of interventions aimed at reducing air pollution and improving respiratory health. As highlighted by Tobias and Otero (2023), studies emphasizing green spaces in urban planning are essential, but they should also assess how these interventions can be tailored to different geographical contexts to maximize their effectiveness. Addressing these geographical gaps will enhance the understanding of global air pollution dynamics and contribute to the development of context-sensitive public health strategies.

**CONCLUSION AND RECOMMENDATIONS**

**Conclusion**

The influence of air pollution on respiratory diseases in urban European areas is a pressing public health concern that necessitates urgent attention and action. Research consistently demonstrates a strong correlation between elevated levels of air pollutants, such as nitrogen dioxide (NO2), particulate matter (PM2.5 and PM10), and ozone, and the incidence of respiratory conditions, including asthma and chronic obstructive pulmonary disease (COPD). Vulnerable populations, particularly children and the elderly, experience disproportionately higher rates of adverse health outcomes related to air pollution exposure. Despite the growing body of evidence highlighting the detrimental effects of air pollution, significant research gaps remain, particularly concerning the cumulative impact of multiple pollutants, long-term exposure effects, and the interplay of socio-economic factors.

To effectively address the challenges posed by air pollution, it is essential to implement comprehensive public health policies that prioritize air quality management, promote green infrastructure, and foster community engagement in monitoring and mitigating pollution. Additionally, ongoing research should focus on understanding the long-term health implications of air pollution, particularly in diverse geographical contexts, to develop targeted interventions that can reduce health disparities. By acknowledging and addressing the multifaceted nature of air pollution and its effects on respiratory health, stakeholders can work collaboratively to create healthier urban environments, ultimately improving the quality of life for residents in European cities and beyond.

**Recommendations**

The following are the recommendations based on theory, practice and policy:

**Theory**

The recommendations on addressing the influence of air pollution on respiratory diseases in urban European areas significantly enhance theoretical frameworks within environmental and public health domains. By reinforcing the idea that clean air is a fundamental determinant of health outcomes, these recommendations stimulate further inquiry into how regulatory frameworks can evolve in light of emerging evidence linking air quality to respiratory diseases. For instance, the integration of green infrastructure into urban design can be situated within ecological health theories, emphasizing the relationship between natural environments and public health. This perspective encourages researchers to explore the health benefits of nature exposure, particularly in mitigating the effects of air pollution. Additionally, public awareness initiatives grounded in health communication theories can elucidate how effective messaging influences community behaviors regarding air pollution, fostering a deeper understanding of the importance of individual and collective actions in reducing health risks.

**Practice**

In practical terms, the recommendations aim to enhance urban planning and public health initiatives through collaborative efforts between city planners and public health officials. Stricter air quality standards, informed by real-time monitoring systems, enable timely interventions that improve community awareness of pollution levels. Furthermore, promoting green infrastructure, such as parks and urban gardens, serves to reduce pollutant concentrations while providing recreational spaces that contribute to mental and physical well-being. Health organizations play a vital role in developing educational programs that inform communities about air pollution sources and health effects. These initiatives empower residents to adopt proactive measures during high pollution days. By prioritizing these practical applications, stakeholders can create healthier urban environments that directly address the respiratory health impacts of air pollution.

**Policy**

From a policy perspective, these recommendations call for a comprehensive approach to air quality management that includes regulatory changes, funding for public awareness campaigns, and support for research initiatives. Governments must enact and enforce policies that reduce emissions from vehicles and industrial sources, thereby significantly lowering levels of nitrogen dioxide (NO2) and particulate matter (PM). Additionally, creating incentives for urban greening initiatives can foster resilience against air pollution's health impacts. Policymakers should also invest in public health campaigns to educate citizens, particularly vulnerable populations, about the risks associated with air pollution and encourage healthier behaviors. Finally, supporting research on the long-term health effects of air pollution is crucial for informed policy decisions. By aligning policy with emerging health concerns related to air quality, governments can effectively mitigate the adverse health impacts associated with pollution and enhance public health outcomes.

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