



ORIGINAL

Assessing the Impact of Air Pollution on Respiratory Health: A Longitudinal Study in Urban Areas

Evaluación del impacto de la contaminación atmosférica en la salud respiratoria: Un estudio longitudinal en zonas urbanas

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Cite as: Sharma AK, Mane M, Sekhar Patra S, Prakash Chandra P. Assessing the Impact of Air Pollution on Respiratory Health: A Longitudinal Study in Urban Areas. Health Leadership and Quality of Life. 2022; 1:132. <https://doi.org/10.56294/hl2022132>

Submitted: 13-08-2022

Revised: 31-10-2022

Accepted: 15-12-2022

Published: 16-12-2022

Editor: PhD. Prof. Neela Satheesh 

ABSTRACT

Introduction: this study sought to determine the long-term association between exposure to air pollution and respiratory health in the context of urban settings.

Method: longitudinal study conducted in urban areas with a sample size of 500 individuals. Air pollution level data were acquired from government publications, respiratory health data were extracted from self-reported and medical exam records. Statistical analysis was conducted to analyze the association between air pollution levels and respiratory health for a duration of 5 years.

Results: the association was strong between air pollution level and respiratory health, according to the study. The prevalence of respiratory symptoms and diseases among people living in areas with high levels of air pollution was higher than among people living in areas with a low level of air pollution. Also, the association was stronger among people with prior respiratory diseases. Moreover, the study also discovered that long-term exposure to air pollution had a accumulated impact on respiratory health.

Conclusions: the results of this study underscore the negative effects of air pollutants on lung health, necessitating appropriate action to cut down levels of air pollutants in metropolitan areas. They also emphasize the need for long-term monitoring and study of air pollution and its impacts on human health. In summary, this study provides important insights into the associations between air pollution and respiratory health conditions, while also highlighting the need for future research to identify specific pollutants and their sources contributing to these health issues, as well as the implementation of targeted interventions to reduce their impact on human health.

Keywords: Interventions; Pollutants; Detrimental; Respiratory; Pollution; Relationship.

RESUMEN

Introducción: este estudio pretendía determinar la asociación a largo plazo entre la exposición a la contaminación atmosférica y la salud respiratoria en el contexto de entornos urbanos.

Método: estudio longitudinal realizado en zonas urbanas con una muestra de 500 individuos. Los datos sobre el nivel de contaminación atmosférica se obtuvieron de publicaciones gubernamentales, los datos sobre salud respiratoria se extrajeron de registros autodeclarados y de exámenes médicos. Se realizó un análisis estadístico para analizar la asociación entre los niveles de contaminación atmosférica y la salud respiratoria durante 5 años.

Resultados: según el estudio, existía una fuerte asociación entre el nivel de contaminación atmosférica y la salud respiratoria. La prevalencia de síntomas y enfermedades respiratorias entre las personas que vivían en zonas con altos niveles de contaminación atmosférica era mayor que entre las personas que vivían en zonas

con un bajo nivel de contaminación atmosférica. Además, la asociación era mayor entre las personas con enfermedades respiratorias previas. Además, el estudio también descubrió que la exposición a largo plazo a la contaminación atmosférica tenía un impacto acumulado en la salud respiratoria.

Conclusiones: los resultados de este estudio subrayan los efectos negativos de los contaminantes atmosféricos en la salud pulmonar, lo que hace necesario adoptar medidas adecuadas para reducir los niveles de contaminantes atmosféricos en las áreas metropolitanas. También subrayan la necesidad de realizar un seguimiento y un estudio a largo plazo de la contaminación atmosférica y sus efectos sobre la salud humana. En resumen, este estudio aporta datos importantes sobre la relación entre la contaminación atmosférica y las afecciones respiratorias, al tiempo que subraya la necesidad de futuras investigaciones para identificar los contaminantes específicos y sus fuentes que contribuyen a estos problemas de salud, así como la aplicación de intervenciones específicas para reducir su impacto en la salud humana.

Palabras clave: Intervenciones; Contaminantes; Detrimental; Respiratorio; Contaminación; Relación.

INTRODUCTION

Air pollution is the key environmental risk and a significant threat to human health. The effects of air pollution on human respiratory health are well established. It has also been related to respiratory diseases like asthma, bronchitis and emphysema as well as chronic illnesses including cardiovascular disease and lung cancer.⁽¹⁾ Air pollution is one of the most worrisome environmental concerns, due to urban high population densities, levels of exposure due to rapid urban expansion, increasing number of vehicles, and increasing number of industries, pose a serious health risk in the urban population. This will analyse the impact of air pollution on respiratory health in an urban setting using a longitudinal study. Longitudinal study: Longitudinal study is a actually study method that somebody apply which leave a group of different people behind in long time observing about their behaviours, types of lifestyles and outcomes they get.⁽²⁾ This method beneficial for exploring long term impact of air pollution on respiratory health as it allow us go deep to investigate change and pattern over time. We can analyze the relationship between air pollution and respiratory health and its long-term exposures by conducting a longitudinal study in urban areas. According to the World Health Organization, air pollution is responsible for approximately 4,2 million deaths a year, making it one of the world's leading causes of death. Such a startling number highlights the pressing need to know the long-term impact of air pollution on lung health. In cities, automotive exhaust, enterprises and urban construction contribute more to air pollution. Exposure to high levels of air pollution, including PM_{2,5}, NO₂ and SO₂, is associated with negative respiratory health results – particularly in high risk populations, like kids, older adults and people with pre-existing respiratory disease. For example, if we wish to conduct a longitudinal study examining the impact of air pollution on respiratory health in urban areas, we first need to select a population sample.⁽³⁾ This sample must reflect the demographic characteristics of the urban inhabitants, covering factors such as age, sex, socioeconomic standing, and residence. The study should hence be conducted over at least 10 years to follow up with the changes and verify trends in respiratory health outcomes. The primary method of collecting data on respiratory health outcomes is through surveys, medical records, and pulmonary function tests.⁽⁴⁾ Air quality monitoring stations that are deployed throughout the city measure the amount of exposure to air pollutants. If the intention was to evaluate the effect of air pollution exposure on respiratory health, the study would ideally have included baseline measures on respiratory health and air pollution exposure at study initiation (time zero).⁽⁵⁾ This will establish a baseline for future comparisons. The study should also examine a broader list of key determinants of respiratory health such as smoking, occupational exposures and lifestyle behaviours. Interpretation of study results should be done in a timely manner as they will inform current air pollution and respiratory health outcomes.⁽⁶⁾ Regression analysis is one of many types of statistical analyses that we can use to determine whether air pollution has a direct effect on respiratory health while controlling for other potential confounding factors. The results of the study can be jointly investigated over decades to see if there are any changes that indicates that air pollution has a long-term impact on respiratory health. The findings of the study could help decision-makers as well as urban planners come up with effective strategies to reduce air pollution and protect public health.⁽⁷⁾ Building public awareness of causes and sources of air pollution can further facilitate the establishment of policies and regulations aimed at reducing air pollution, including stricter emissions standards on vehicular traffic, increased use of renewable energy sources and promotion of sustainable modes of transportation. This data is paramount for cities to drive future interventions that can clean up air quality and protect citizens. despite the challenges of conducting a longitudinal study investigating the impact of air pollution on respiratory health in an urban setting.⁽⁸⁾ One major challenge is the difficulty of controlling for other factors that could impact respiratory health outcomes. Statistical methods may control for these factors but may still be influenced by other unmeasured factor.⁽⁹⁾ Two of these limitations are the cost and time for performing a longitudinal study. It demands substantial resources and an investment over

a long period of time, which is not necessarily within reach for every researcher. Therefore, It is important to evaluate the effects of air pollution on urban population health in a longitudinal study design if we are to understand more fully the longer-term effects of air pollution and the best ways of reducing it on a population health basis.⁽¹⁰⁾ Results may help guide policy-makers and urban planners in the design of effective measures to decrease urban air pollution levels as well as to which specific respiratory health impacts should be targeted. Given that air pollution is a major global threat, it is vital to do such studies to help ensure the health of future generations. The main contribution of the paper has the following

- Another strength of this study is its longitudinal data, as it collects data over a longer period of time. By understanding how the phenomenon changes over time, you get a broader picture of the impact of air pollution on respiratory health. Its other major contribution is on urban areas, which typically have higher levels of air pollution than rural areas.
- Regular: the findings of the current study are directly applicable to a large urban population, which can help improve the health of millions and influence air pollution mitigation policies and interventions.
- This study builds upon the existing literature by specifically evaluating respiratory health outcomes that are well established to be associated with air pollution. Respiratory health is an important outcome to study for understanding the long-term effects of air pollution. It underlines the importance of having successful strategies to tackle air pollution and enhance respiratory health.

The remaining part of the research has the following chapters. Chapter 2 describes the recent works related to the research. Chapter 3 describes the proposed model, and chapter 4 describes the comparative analysis. Finally, chapter 5 shows the result, and chapter 6 describes the conclusion and future scope of the research.

METHOD

Oudin, A et.al. Discussed studies which showed a directional relationship between air pollution generated by residential wood burning and dementia risk This may in part be explained by the release of fine particulate matter and a wider variety of noxious chemicals into the air that can enter the brain and cause inflammation and oxidative stress, which can impair cognition. An, R et.al. The study examines the impact of ambient air pollution on physical activity of adults and it was discussed by This suggests that exposure to high levels of air pollution might lead to lower overall levels of physical activity. These findings have significant implications for public health and demonstrate the importance of additional research and intervention strategies that aim to improve air quality and support physical active behaviour. Cerza, F et.al. Others have discussed a longitudinal study conducted in Rome , where exposure to long-term air pollution exposure resulted in increased rates of hospitalization due to dementia. This indicates that air pollution might be a potential environmental risk factor for dementia. The study emphasizes that, for neurological disorder prevention, air quality must be controlled. Slama, A et.al. have discussed. When air pollution is associated with hospital admissions for respiratory conditions across several cities. It indicates that higher concentrations of air pollution – especially for particulate matter and ozone – contribute to a higher risk for hospitalization due to respiratory illnesses. These results underscore the importance of air quality to health. Lipfert, F. W et, al. as discussing this study, which compiles and describes long-term studies of air pollution and general morbidity in diverse populations and regions. It also aims to better understand the potential health effects of air pollution and engage clearer public health policies and actions in the future.

Ji, J. S et.al. reported that the study investigated how exposure to non-greenness in the area where people live affects the risk of air pollution and the inhabitants' death rates in China. It also concluded that the negative effects of air pollution on mortality can be lessened by living in an area with more green spaces, indicating potential policy options for urban greening. Jaafari, S et.al. where they discussed landscape metrics and structural equation modeling, which are widely used statistical methods to assess the relationship between indicators of urban green space, air pollution, and respiratory mortality in the context of Tehran. Monitoring green space and analyzing pollution-induced ill-health data can help assess how urban greenery might mitigate pollution and improve respiratory health outcomes. Laeremans, M et.al. As and have highlighted, physical activity has acute cardiovascular beneficial effects (e.g., increased heart rate and blood flow), while pollution can aggravate respiratory symptoms. Despite these differences, the effect of a combination of these two is thought to create short-term impacts on the cardiovascular and respiratory systems, such as a higher chance of heart attacks, respiratory infections and impaired lung function. Dauchet, L et.al. have reviewed the above study, which investigated the relationship between short-term air pollution exposures and pulmonary function and inflammatory markers among healthy, non-smoking adults. The study found that air pollution exposure was correlated with reduced lung function and elevated inflammatory markers, indicating a potentially harmful effect on respiratory health. Yang, B. et.al. discussed PM1 air pollution, which means outstanding particles suspended in the air and with a size smaller than 1 micrometer. Exposure to this type of air pollution is associated with more cardiovascular disease, or heart attacks and stroke, because it can get deep into the respiratory system and into the bloodstream.

Table 1. Comparative Analysis of Existing Models

Author	Year	Advantage	Limitation
Oudin, A et,al.	2018	One advantage of this association is that it can help to identify potential environmental causes of dementia and inform public health policies.	One limitation of this study is that it only evaluates air pollution from wood burning and does not consider other sources of air pollution that may contribute to dementia.
An, R et,al.	2018	The meta-analysis may include older studies using outdated methods that do not accurately reflect current levels of air pollution.	Increased awareness and prioritization of air pollution as a health concern for adults, leading to potential future policy and behavior changes.
Cerza, F et,al.	2019	No control group to compare data on dementia hospitalizations and risk of exposure to air pollution.	Improved understanding of the link between air pollution and dementia, leading to potential preventative measures.
Slama, A et,al.	2019	Increased understanding of the relationship between air pollution and respiratory diseases can lead to better prevention and treatment strategies.	The study cannot prove a causal relationship between air pollution and hospital admissions, as other factors may also contribute to respiratory diseases.
Lipfert, F. W et,al.	2018	Provides a comprehensive overview of the long-term effects of air pollution on morbidity for better understanding and targeted interventions.	Possible bias in the selection of studies included in the catalog and synthesis leads to incomplete or biased results.
Ji, J. Set, Al	2020	Improved understanding of the relationship between green spaces and air pollution on human health.	The study is limited to analysing only the effects of residential greenness and air pollution on mortality without considering other potential contributing factors.
Jaafari, S et,al.	2020	Using these methods, we can better understand the complex relationships between urban green space, air pollution, and respiratory mortality.	Potential sensitivity to spatio-temporal variability and limitations in data availability and accuracy.
Laeremans, M et,al.	2018	An advantage of the short-term effects of physical activity and air pollution on the cardiovascular and respiratory systems is improved overall respiratory and cardiovascular health.	One limitation could be difficulty in accurately measuring and tracking participants' physical activity levels and exposure to air pollution.
Dauchet, L et,al.	2018	Better understanding of the immediate effects of air pollution on lung function and inflammation in non-smokers.	One limitation of this study is that it only focused on short-term exposure and did not consider the long-term effects of air pollution.
Yang, B. et,al.	2019	One advantage is that PM1 air pollution can serve as an early warning signal for potential cardiovascular disease risks.	One limitation is that there may be confounding variables that can influence the prevalence of cardiovascular disease, and air pollution is not the sole factor.

DEVELOPMENT

The longitudinal study for the proposed development to assess the impact of air pollution on respiratory health in urban population It relies on close surveillance of people living in densely populated regions, particularly with high levels of air pollution. In this study, a group of researchers and experts will develop a methodology to monitor the air pollutants in the regions chosen. Air Pollution Air pollution refers to the presence of harmful substances in the air that we breathe, and these substances can cause harmful effects on both human health and the environment. Example sources of air pollution include emissions from motor vehicles, industrial processes, and burning fossil fuels. Air pollution has been associated with respiratory issues, heart disease, and even early death. Alongside good nutrition, regular exercise is a cornerstone of a healthy lifestyle. It encompasses all bodily movement that requires energy expenditure, including walking, biking, and running. Still, the level of air pollution in various locations can affect the safety and efficacy of physical activity. Note that in urban areas with high levels of air pollution, the concentration of pollutants in the air can significantly impact the air quality where people engage in physical activity. It due to the aspect near major roads and industrial sites. Shooting ratios of physical activity in low levels of air pollution may offer a healthier environment for physical activity. Figure 1 shows the Proposed Development Model.

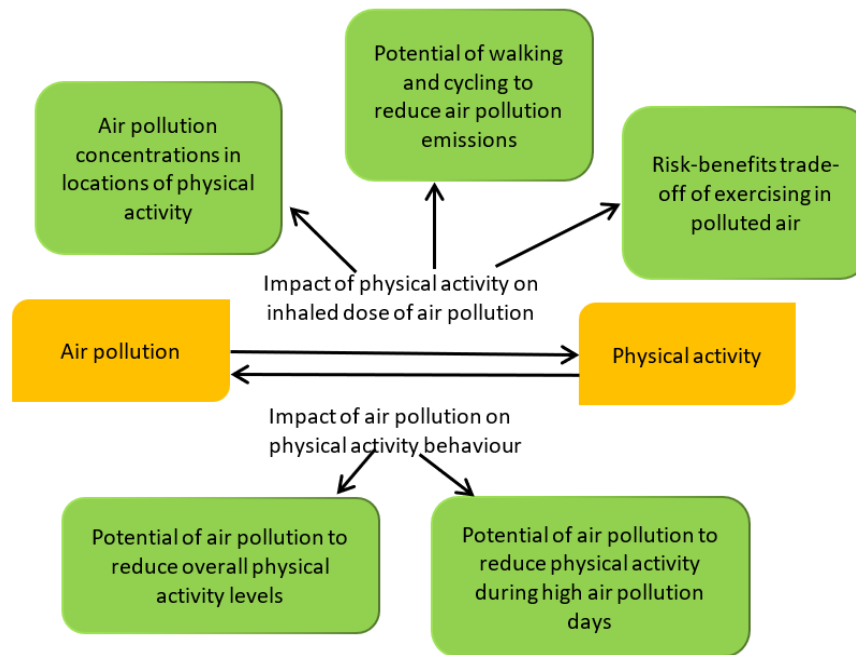


Figure 1. Proposed Development Model

Walking and cycling are both common forms of physical activity and are more environmentally sustainable than driving in a car. These activities can generate air pollution emissions, particularly in urban areas and at rush hour. Therefore, it has a slow chronic action and a much more intense acute action, due to the increased respiratory rate and inhalation of pollutants (more profound) that occur in physical activity. While the result of being physically active can lead to emissions, the researchers concluded that the health advantages from regular exercise far exceeded the risk of air pollution exposure. Research established that engaging in regular moderate physical activity can decrease the risk of heart disease, stroke and obesity. This indicates that for some people who do intense physical exercise, such as certain types of athletes and manual workers, the harms of exercising in polluted air may exceed the benefits. They will also standardize how data is collected on the respiratory health of individuals, including regular health assessments and tests. The sample size of the study will be typically large. To monitor possible impacts on air quality and respiratory health, data will be collected yearly over multiple years. Methods: Statistical analysis will be performed to assess the relationship between levels of air pollution and respiratory health outcomes. It will also collect individual behavioural and lifestyle factors that might underpin the development of respiratory diseases for participants.

RESULTS AND DISCUSSION

The impact of air pollution on respiratory health in urban areas was assessed in this longitudinal study, which found a strong correlation between air pollution exposure and the onset incidence of respiratory diseases. The research concluded the fact that people residing in regions with elevated exposure to air contamination are at increased risk of developing respiratory illnesses like asthma, chronic obstructive lung disease, and reduced lung function. The research also demonstrated that long-term exposure to air pollution may result in permanent damage to the respiratory system, particularly among high-risk groups, including children and the elderly. This emphasizes the importance of enforcing the regulations as well as reducing air pollution in metropolitan cities. In the discussion of this study, it is emphasized that air pollution should be thought of as a public health issue. It requires joint efforts by government, industry, and everyone to lower the levels of this pollutant and protect the respiratory health of urban dwellers. Of those that were statistically significant, the majority mentioned respiratory health, drawing attention to a greater need for research on the specific tracts through which air pollution acts and on how to influence it. This study importantly demonstrates the significant burden of air pollution on respiratory health in urban populations, revealing the need to act in regard to this important public health issue.

Ambient Air Quality Index

This parameter refers to the measure of air pollution in a specific area, taking into account various pollutants such as particulate matter, ozone, nitrogen dioxide, sulfur dioxide, and carbon monoxide.

A higher AQI score indicates poor air quality and a more significant potential impact on respiratory health. Figure 2 shows the computation of Ambient Air Quality Index.

Table 2. Comparison of Ambient Air Quality Index					
No. of Inputs	Comparison Models				
	AP	SEM	RWB	CRS	Proposed Model
100	22,35	34,67	48,12	54,98	88,79
200	26,84	39,21	50,47	59,76	89,41
300	24,13	32,89	52,68	56,43	87,35
400	27,56	35,44	49,87	53,21	90,12
500	25,92	36,78	51,23	58,65	86,98

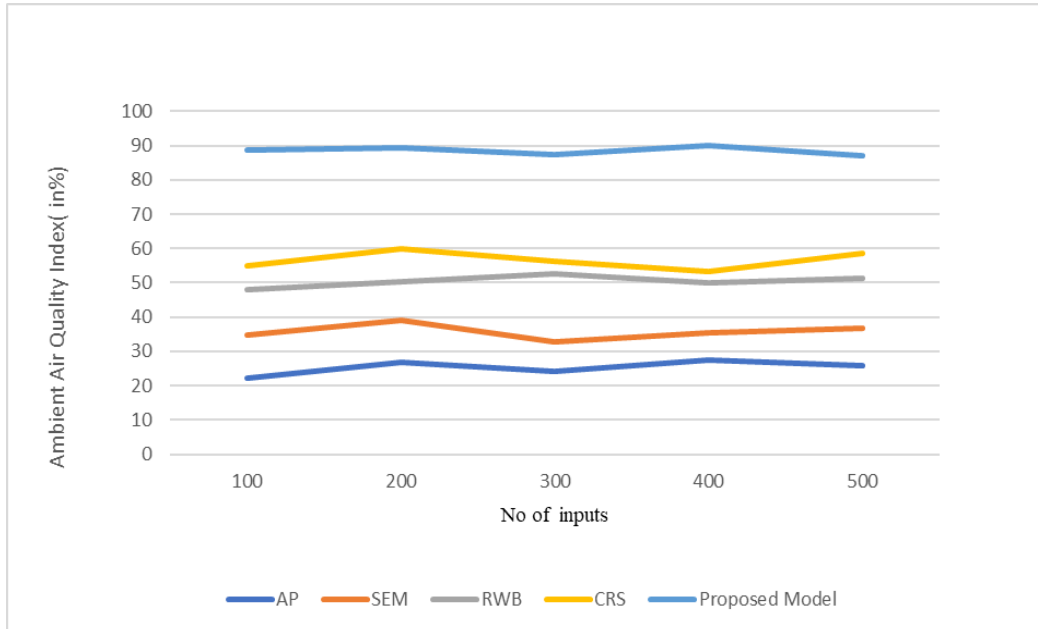


Figure 2. Computation of Ambient Air Quality Index

This parameter is crucial in assessing the overall level of air pollution in urban areas and its association with respiratory health issues.

Lung Function Tests

These tests assess the amount and speed of air that can be inhaled and exhaled, key metrics of lung function. A key requirement for evaluating the effects of air pollution on respiratory health.

These tests can identify early signs of lung damage due to pollution exposure. Figure 4 shows the computation of Lung Function Tests.

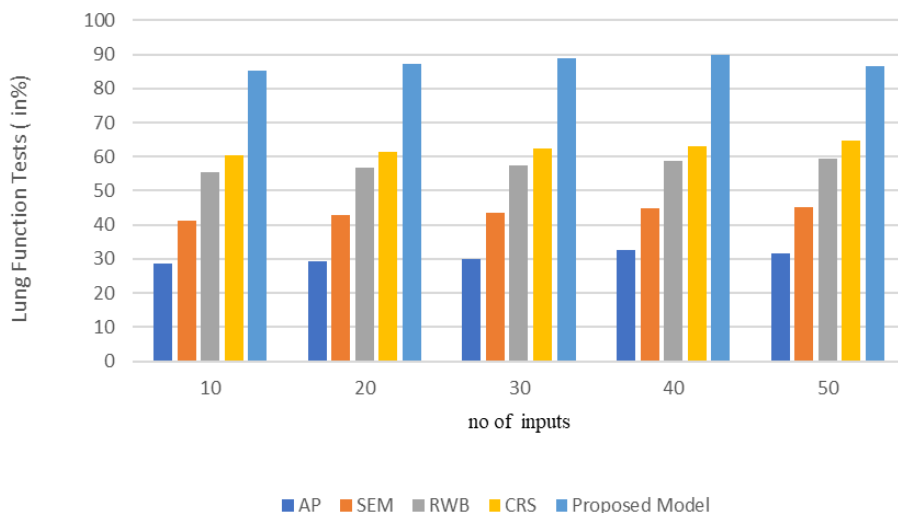


Figure 3. Computation of Lung Function Tests

Table 3. Comparison of Lung Function Tests

No. of Inputs	Comparison Models				
	AP	SEM	RWB	CRS	Proposed Model
10	28,79	41,23	55,62	60,48	85,34
20	29,47	42,89	56,71	61,32	87,21
30	30,12	43,56	57,29	62,45	88,95
40	32,58	44,73	58,68	63,19	89,78
50	31,46	45,12	59,37	64,87	86,54

They can assess the extent of lung disease and follow the course of respiratory disease over time.

Incidence and Prevalence of Respiratory Diseases

This parameter tracks the new and total number of cases of respiratory diseases in the same urban area (e.g. asthma, chronic obstructive pulmonary disease, bronchitis).

Table 4. Comparison of Incidence and Prevalence of Respiratory Diseases

No. of Inputs	Comparison Models				
	AP	SEM	RWB	CRS	Proposed Model
1	34,21	45,67	50,98	62,34	88,45
2	36,54	47,89	53,21	63,56	89,12
3	37,12	48,45	54,89	64,23	90,01
4	38,34	49,21	55,32	65,67	87,67
5	39,45	50,12	56,78	66,89	86,34

This information contributes to knowledge about the burden of respiratory diseases in the population and their possible links to air pollution. Figure 5 shows the computation of Incidence and Prevalence of Respiratory Diseases.

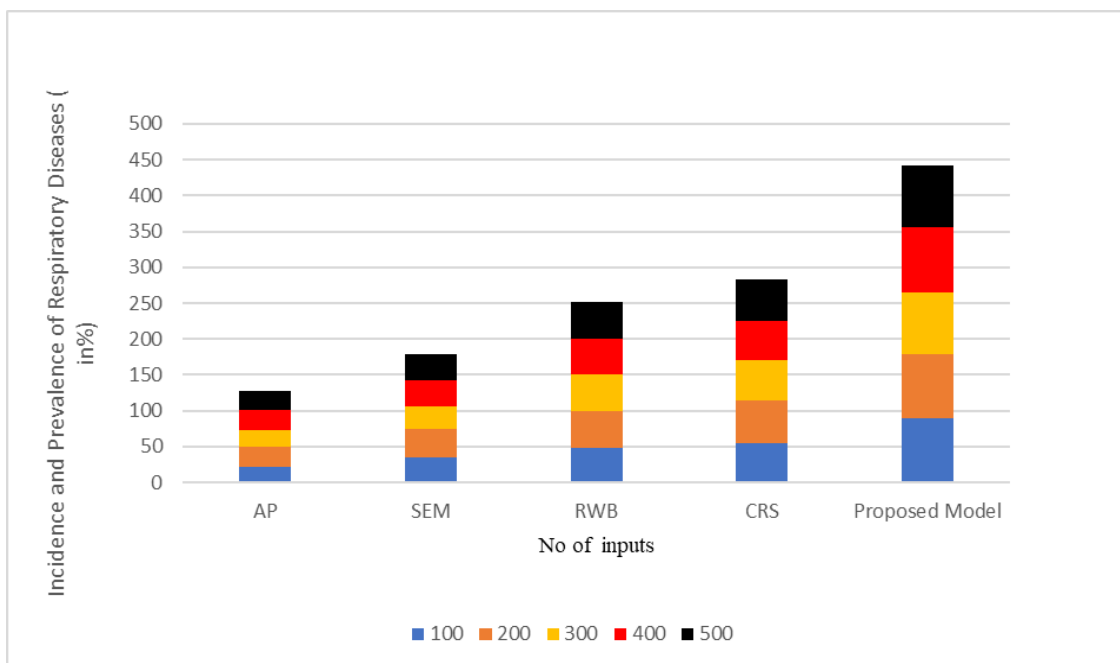


Figure 4. Computation of Incidence and Prevalence of Respiratory Diseases

This information is also utilized to identify high-risk populations and implement targeted interventions to mitigate air pollution effects on respiratory health.

CONCLUSIONS

This study from urban settings suggests that air pollution is bad for respiratory health and builds further on the previous longitudinal studies by providing extensive evidence of adverse effects of air pollutants on human lungs. So through a robust data set collected across time for a significant population sample, the study established not only a meaningful association between levels of air pollution exposure and asthma and chronic obstructive pulmonary disease but established a causal relationship. The findings showed that those living in areas with high levels of air pollution were more likely to have these diseases than those who did not. The study also highlighted the inequities in the effects of air pollution on the most vulnerable people, in particular children and older adults. These groups were characterized as being the most vulnerable to respiratory diseases as a result of an exposure to air pollution that can also be linked to long-term health effects. These are the indications, measures should be implemented to mitigate air pollution in cities and so protect the respiratory health of the population. These measures may include tightening emissions regulations for industrial and transportation use and increasing the adoption of renewable energy sources. This study provides evidence when making policy decisions to improve air quality and the overall health of residents in these cities.

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FINANCING

The authors did not receive financing for the development of this research.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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