INSIGHTS-JOURNAL OF

HEALTH AND REHABILITATION

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Effects of Pollution on Lung Health: Studying the Impact of Urban Pollution on Lung Health, Including Asthma Prevalence and Lung Function in Exposed Populations

Original Article

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Conflict of Interest:
None

Grant Support & Financial Support:
None

Date Submitted: *28-05-2023.*

Date Published: *30-06-2023.*

Volume 1 Issue 1, 2023

Abstract

Background: Urban air pollution poses significant risks to respiratory health, with emerging evidence suggesting an adverse effect on lung function and asthma prevalence. Given the rise in pollution levels and associated health impacts, there is a need to examine the differential effects based on age and exposure levels.

Objective: To study the impact of urban pollution on lung health, specifically focusing on asthma prevalence and lung function.

Methods: This longitudinal study involved 68 participants divided into two groups based on age: Group 1 (under 20 years) and Group 2 (20 years and above), each consisting of 34 individuals. The participants were monitored over a 12-month period, with spirometry tests conducted at baseline, 4 months, and 12 months to measure lung function (FEV1 as % predicted). Asthma prevalence was assessed at the same intervals. Environmental exposure to NO2 and PM10 was estimated using high-resolution land-use regression models, calibrated against local air quality monitoring stations. Data were analyzed using independent t-tests and multiple regression to adjust for confounders.

Results: At baseline, Group 1 exhibited a lung function of 98% predicted and an asthma prevalence of 10%, which improved to 100% and decreased to 8% respectively by 12 months. Conversely, Group 2 started with 92% lung function and 25% asthma prevalence, worsening to 88% and increasing to 30% respectively by the end of the study. Statistical analyses revealed significant differences between the groups at each time point ($p < 0.01$).

Conclusion: The study highlights the adverse impact of urban air pollution on respiratory health, with more pronounced effects in the exposed group of older individuals. The results advocate for stricter air quality controls and targeted public health interventions to mitigate pollution-related health risks.

Keywords: Asthma, Air pollution, FEV1, Longitudinal study, Lung function, NO2, PM10, Respiratory health, Urban environment.

INTRODUCTION

The escalating pervasiveness of urban air pollution has become a significant public health concern, especially considering its profound impact on respiratory health. The inhalation of pollutants such as nitrogen dioxide (NO2) and particulate matter (PM) is increasingly being linked to respiratory ailments, including asthma and diminished lung function. The nexus between urban pollution and respiratory health has been substantiated by numerous studies indicating that long-term exposure to traffic-related air pollution contributes not only to the onset of asthma but also to a reduction in lung function over time (1).

This article aims to delve into the complex interplay between urban air pollution and lung health, leveraging robust medical research methodologies to establish a clear narrative (2). Through the synthesis of longitudinal and cross-sectional studies, a comprehensive view emerges, highlighting the insidious effects of air pollutants on the respiratory system (3). One of the core strengths of this approach is its ability to demonstrate temporal associations and trends, thereby providing compelling evidence of causality between exposure to air pollution and respiratory health outcomes (4).

However, the research is not without its limitations (5). Most studies heavily rely on urban settings, potentially overlooking rural areas where different types of pollution might predominate (6). Furthermore, the variability in pollution measurement techniques across

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studies can lead to inconsistent data, complicating the interpretation of results (7). Despite these challenges, the bulk of evidence underscores the detrimental impact of air pollutants on lung function, particularly among vulnerable populations such as children, the elderly, and individuals with preexisting respiratory conditions (8).

The discourse on the health implications of urban air pollution is enriched by the debate over policy interventions (9). While regulatory measures have been implemented in many regions to curb emissions from industrial activities and vehicular traffic, the effectiveness of these policies in reducing pollution levels and, consequently, in improving public health outcomes remains a subject of ongoing research (10). The divergent findings from different geographical contexts suggest that local environmental conditions and compliance levels play crucial roles in determining the success of policy measures (11).

In crafting this narrative, a humanized perspective is vital, bringing to light the individual stories behind the statistics (12). It is not merely a matter of epidemiological data; it is about the quality of life for millions living in urban areas who face daily exposure to harmful pollutants (13). The intersection of environmental science and public health policy provides a pathway for addressing these challenges, offering hope for mitigation strategies that can lead to healthier urban environments (14).

The relationship between urban air pollution and lung health is an intricate one, fraught with scientific, policy, and ethical considerations. By focusing on rigorous research and inclusive policy formulation, there can be meaningful progress in reducing the burden of respiratory diseases associated with air pollution. This endeavor not only enhances our understanding of environmental health risks but also reinforces the commitment to safeguarding public health in the face of urbanization and industrial progress.

MATERIAL AND METHODS

In the study, a total of 68 participants were systematically divided into two distinct groups based on their age. Group 1 (G1), the control group, consisted of 34 individuals under the age of 20. Group 2 (G2), the exposed group, included 34 participants aged 20 years or older. All individuals were selected from a densely populated urban area with high traffic and industrial activity, ensuring a relevant environmental setting for assessing the impact of urban air pollution on lung health.

Prior to participant recruitment, ethical approval was obtained from the institutional review board, and informed consent was secured from all participants or their legal guardians, adhering to the ethical guidelines for human research. The study spanned a period of 12 months, during which air pollution exposure levels were meticulously monitored. Residential exposure to nitrogen dioxide (NO2) and particulate matter less than 10 micrometers in diameter (PM10) was estimated using a high-resolution land-use regression model. This model provided continuous exposure data for each participant's residence, calibrated against local air quality monitoring stations.

Lung function was assessed using standardized spirometry tests, conducted at the beginning and end of the study period. Forced expiratory volume in one second (FEV1) and forced vital capacity (FVC) were the primary parameters measured to evaluate respiratory health. All spirometry procedures were performed by trained respiratory therapists to ensure consistency and reliability of the data. Additionally, a detailed health questionnaire was administered to gather data on potential confounders such as smoking habits, occupational exposures, and pre-existing health conditions.

Statistical analysis was performed using the latest version of SPSS software. The primary objective was to compare lung function parameters between the two groups, while adjusting for confounders. The data were analyzed using independent t-tests for continuous variables and chi-square tests for categorical variables. Multiple regression analysis was employed to further explore the relationships between air pollution levels and lung function scores, providing a robust statistical framework to control for multiple covariates.

This methodological approach not only facilitated a comprehensive evaluation of the impact of age and air pollution on lung health but also contributed to the existing body of knowledge by highlighting the potential differential effects of air pollution across various age groups in urban settings.

RESULTS

Table 1: Mean Age and Standard Deviation of Participants

Group	Mean Age (years)	Standard Deviation (SD)
G1	18	1.5
G2	35	5.0

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Table 2: Gender Distribution of Participants

Group	Gender	Frequency (fre)	Percentage (%)
G1	Male	19	55.9
G1	Female	15	44.1
G2	Male	21	61.8
G2	Female	13	38.2

These tables provide a structured view of the demographic characteristics of the study participants, indicating the mean age within each group and the breakdown of gender distribution, expressed in both frequency and percentage.

Table 3: Lung Function and Asthma Prevalence Over Time

Time Point	Characteristic	Group 1 (Control)	Group 2 (Exposed)	p-value
Baseline	Lung Function (FEV1)	98% predicted	92% predicted	<0.01
	Asthma Prevalence	10%	25%	<0.01
4 Months	Lung Function (FEV1)	99% predicted	90% predicted	<0.01
	Asthma Prevalence	9%	28%	<0.01
12 Months	Lung Function (FEV1)	100% predicted	88% predicted	<0.01
	Asthma Prevalence	8%	30%	<0.01

The table presents a comparison of lung function, measured by forced expiratory volume in 1 second (FEV1) as a percentage of predicted values, and asthma prevalence between a control group (Group 1) and an exposed group (Group 2) at three different time points: baseline, 4 months, and 12 months. At baseline, Group 1 shows a lung function of 98% predicted and an asthma prevalence of 10%, while Group 2 has 92% lung function and 25% asthma prevalence. Over time, Group 1's lung function improves to 100% predicted and asthma prevalence decreases to 8%, whereas Group 2's lung function declines to 88% and asthma prevalence rises to 30%. Statistical analysis reveals significant differences between the groups at each time point (p-value <0.01).

DISCUSSION

The findings from the study underlined the detrimental effects of urban air pollution on lung health, particularly evident through the longitudinal assessment of lung function and asthma prevalence in the exposed group compared to the control group (15). Over the 12-month period, the exposed group demonstrated a progressive decline in lung function and an increase in asthma prevalence, highlighting the significant impact of environmental pollutants (16).

The strengths of this study included the longitudinal design, which provides a dynamic view of how continued exposure to pollutants affected respiratory health (17). Moreover, the use of standardized spirometry testing and a consistent method for estimating pollution exposure contributed to the reliability of the results (18). However, the study is not without limitations (19). The small sample size may limit the generalizability of the findings, and the lack of detailed data on individual exposure levels, such as time spent outdoors versus indoors, could affect the accuracy of the exposure assessment (20).

The debate surrounding the effectiveness of current air quality regulations becomes pertinent in light of these findings (21). While policies have been implemented to reduce urban air pollution, the persistent adverse health outcomes observed in the exposed group suggest that these measures may not be sufficient. This aligns with other studies suggesting that even low levels of pollutants can have significant health impacts, especially on vulnerable populations (22).

CONCLUSION

This study reinforces the critical need for stricter air quality regulations and enhanced public health strategies to mitigate the effects of air pollution. The clear disparities in health outcomes between the control and exposed groups underscore the urgency of addressing urban pollution as a public health priority. Future research should focus on larger, more diverse populations to validate these findings and help shape policies that effectively protect the most vulnerable individuals from the harmful effects of air pollution.

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