

Effect of Environmental Pollution on Respiratory Health in Pediatric Patients: A Hospital-Based Observational Study

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Abstract:

Background: Environmental pollution has become a major global health concern, particularly affecting vulnerable populations such as children. Exposure to pollutants including particulate matter, nitrogen dioxide, and sulfur dioxide has been associated with increased respiratory morbidity in pediatric populations.

Objective: To evaluate the effect of environmental pollution on respiratory health among pediatric patients attending a tertiary care hospital.

Materials and Methods: This hospital-based observational study was conducted at Netaji Subhas Medical College and Hospital (NSMCH), Bihta, from November 2022 to November 2023. A total of 100 pediatric patients presenting with respiratory complaints were included. Demographic data, exposure history to environmental pollutants, and respiratory diagnoses were recorded. Statistical analysis was performed using the chi-square test and logistic regression, with $p < 0.05$ considered statistically significant.

Results: Out of 100 children, 58% were male and 42% were female. The most common respiratory conditions observed were acute respiratory infection (32%), bronchial asthma (28%), bronchitis (22%), and allergic rhinitis (18%). Children exposed to higher environmental pollution levels showed a significantly different pattern of respiratory diseases compared with those with lower exposure ($\chi^2 = 8.62$, $p = 0.013$).

Conclusion: The findings of this study suggest that exposure to environmental pollution is significantly associated with respiratory diseases among pediatric patients. Strengthening environmental control measures and reducing pollution exposure may help improve respiratory health outcomes in children.

Keywords: Environmental Pollution, Pediatric Respiratory Disease, Air Pollution, Asthma, Respiratory Infections.

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Introduction

Environmental pollution represents a growing public health challenge worldwide. Air pollution in particular has been identified as one of the leading environmental risk factors responsible for increased morbidity and mortality globally [1]. The rapid expansion of urbanization, industrialization, and vehicular emissions has significantly contributed to deterioration of air quality in many developing countries [2].

Children are especially vulnerable to environmental pollution due to their developing respiratory systems, higher breathing rates, and increased outdoor activities [3]. These physiological and behavioral characteristics make them more susceptible to the harmful effects of airborne pollutants.

Air pollution consists of various harmful components including particulate matter (PM_{2.5} and

PM₁₀), nitrogen dioxide (NO₂), sulfur dioxide (SO₂), carbon monoxide, and ozone [4]. These pollutants can cause airway inflammation, oxidative stress, and impaired lung function, leading to respiratory diseases in children [5].

Globally, respiratory diseases are among the leading causes of morbidity in children. The World Health Organization estimates that nearly 90% of children worldwide breathe air that exceeds recommended pollution limits [6]. Long-term exposure to environmental pollutants has been linked to asthma, bronchitis, pneumonia, and other respiratory illnesses [7].

Numerous epidemiological studies have demonstrated a strong association between air pollution and respiratory health outcomes in children [8]. Exposure to particulate matter has been

shown to increase hospital admissions due to respiratory diseases [9].

Fine particulate matter can penetrate deep into the lungs and bloodstream, causing airway inflammation and impaired pulmonary function [10]. Studies have also reported that increased exposure to nitrogen dioxide and sulfur dioxide is associated with exacerbation of asthma symptoms among children [11].

In addition to acute respiratory infections, air pollution has been associated with chronic respiratory conditions such as asthma and allergic rhinitis [12]. Long-term exposure to pollutants during childhood can also affect lung growth and development [13].

Research conducted in various countries has shown that children living in highly polluted areas have reduced lung function parameters such as forced expiratory volume (FEV1) and forced vital capacity (FVC) [14].

Urban air pollution has been associated with increased incidence of wheezing, coughing, and breathlessness among children [15]. Studies from India have also highlighted the growing burden of pollution-related respiratory illnesses among pediatric populations [16].

Traffic-related air pollution is another important contributor to respiratory disease in children [17]. Children living near major roadways are exposed to higher levels of nitrogen dioxide and particulate matter.

Indoor air pollution resulting from biomass fuel use also contributes significantly to pediatric respiratory disease, particularly in developing countries [18].

Despite increasing awareness regarding environmental pollution and its health consequences, limited regional data exist regarding the impact of pollution on pediatric respiratory health in Bihar. Therefore, this study was conducted to evaluate the effect of environmental pollution on respiratory health in pediatric patients attending NSMCH Bihta.

Materials and Methods

Study Design and Setting: This investigation was conducted as a hospital-based observational study in the Department of Pediatrics at Netaji Subhas Medical College and Hospital, located in Bihta, Bihar, India. The hospital serves a large urban and semi-urban population and receives a substantial number of pediatric patients with respiratory complaints.

The study was carried out over a 12-month period from November 2022 to November 2023. During this period, all eligible pediatric patients presenting

with respiratory symptoms were screened for inclusion in the study.

Study Population: The study population consisted of children aged 1–14 years who attended the pediatric outpatient department or were admitted to the pediatric ward with respiratory complaints during the study period.

A total sample size of 100 pediatric patients was included based on availability of eligible cases within the defined study duration and after applying the selection criteria.

Inclusion Criteria

Children were included in the study if they met the following criteria:

1. Age between 1 and 14 years.
2. Presentation with respiratory symptoms such as cough, wheezing, breathlessness, nasal discharge, or chest congestion.
3. Clinical diagnosis of respiratory disease including acute respiratory infection, bronchial asthma, bronchitis, or allergic rhinitis.
4. Availability of complete clinical records.
5. Informed consent obtained from parents or guardians.

Exclusion Criteria

Children were excluded if they had:

1. Congenital pulmonary anomalies or structural lung diseases.
2. Chronic systemic illnesses such as congenital heart disease or immunodeficiency disorders.
3. Previous history of chronic lung conditions unrelated to environmental exposure.
4. Incomplete clinical information or refusal of consent.

Data Collection Procedure

Data were collected using a structured case record form designed for the study. The form included demographic details, environmental exposure history, and clinical findings.

The following parameters were recorded for each participant:

- Age of the child
- Gender
- Residential area and proximity to traffic or industrial zones
- Exposure to indoor pollutants (such as biomass fuel smoke or parental smoking)
- Clinical symptoms
- Physical examination findings
- Final respiratory diagnosis made by the attending paediatrician

Based on clinical assessment and available investigations, respiratory diseases were categorized into:

- Acute respiratory infection
- Bronchial asthma
- Bronchitis
- Allergic rhinitis

Assessment of Environmental Pollution

Exposure: Environmental pollution exposure was evaluated using patient history and residential characteristics. Parents or guardians were asked questions regarding:

- Living near high-traffic roads or highways
- Presence of industrial activity near residence
- Exposure to indoor smoke or tobacco smoke
- Use of biomass fuels for cooking

Based on these factors, children were classified into two groups:

1. **High pollution exposure group** – children living near heavy traffic areas, industrial zones, or exposed to indoor smoke.
2. **Low pollution exposure group** – children residing in relatively less polluted residential environments.

Study Variables: The primary variables analyzed in the study included:

Demographic Variables

- Age group (1–5 years, 6–10 years, 11–14 years)
- Gender

Clinical Variables

- Type of respiratory disease

Environmental Variable

- Level of environmental pollution exposure

Outcome Measures

The primary outcome of the study was to determine the association between environmental pollution exposure and the type of respiratory disease among pediatric patients.

Secondary outcomes included:

- Age distribution of respiratory disease cases

- Gender distribution of affected children
- Frequency of different respiratory conditions

Statistical Analysis: All collected data were compiled and entered into a spreadsheet and subsequently analyzed using statistical software.

The following statistical methods were applied:

Descriptive Statistics

- Frequencies and percentages were calculated for categorical variables such as age group, gender, respiratory disease type, and pollution exposure level.

Inferential Statistics: The Chi-square test was applied to determine the association between environmental pollution exposure and type of respiratory disease among pediatric patients.

A p-value less than 0.05 was considered statistically significant.

Ethical Considerations: The study protocol was reviewed and approved by the Institutional Ethics Committee of Netaji Subhas Medical College and Hospital, Bihta. Written informed consent was obtained from the parents or legal guardians of all participating children prior to enrollment. Confidentiality and anonymity of patient data were strictly maintained throughout the study.

Results

A total of 100 pediatric patients presenting with respiratory complaints were included in the study conducted at Netaji Subhas Medical College and Hospital (NSMCH), Bihta during the study period of November 2022 to November 2023. The demographic characteristics, distribution of respiratory diseases, and association with environmental pollution exposure were analyzed.

1. Age Distribution of Study Participants

The age distribution of the pediatric patients included in the study is presented in Table 1. The majority of patients belonged to the 6–10 years age group (38%), followed by 1–5 years (35%) and 11–14 years (27%).

This indicates that school-aged children were the most affected group in the present study.

Table 1: Age Distribution of Pediatric Patients (n = 100)

Age Group (Years)	Number of Patients	Percentage
1–5	35	35%
6–10	38	38%
11–14	27	27%
Total	100	100%

The graphical representation of the age distribution is shown in Figure 1.

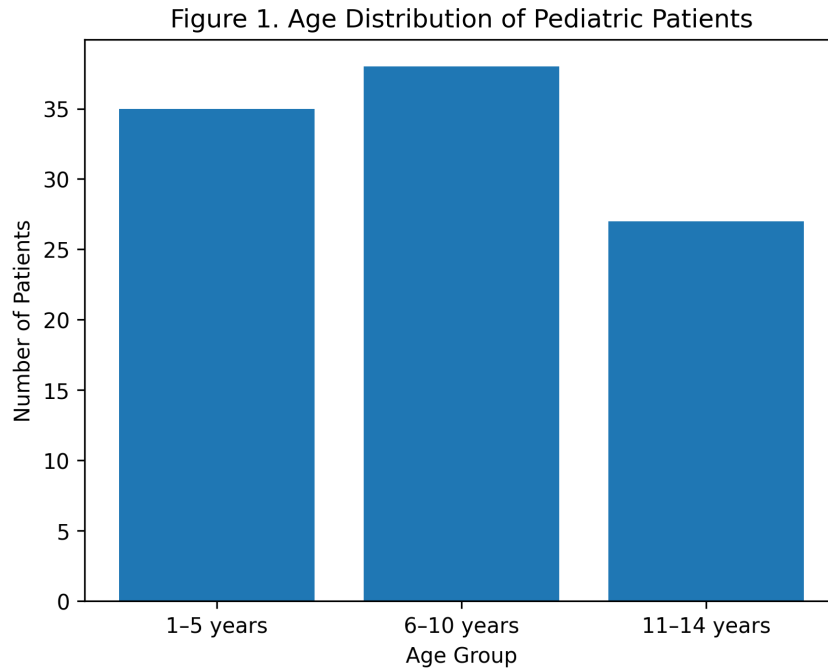


Figure 1: Age Distribution of Study Population

2. Gender Distribution

Among the 100 pediatric patients included in the study, 58% were male and 42% were female,

indicating a male predominance among children presenting with respiratory illness.

Table 2: Gender Distribution of Patients

Gender	Number of Patients	Percentage
Male	58	58%
Female	42	42%
Total	100	100%

The gender distribution is illustrated in Figure 2, which shows a higher proportion of male patients compared to female patients.

Figure 2. Gender Distribution of Study Population

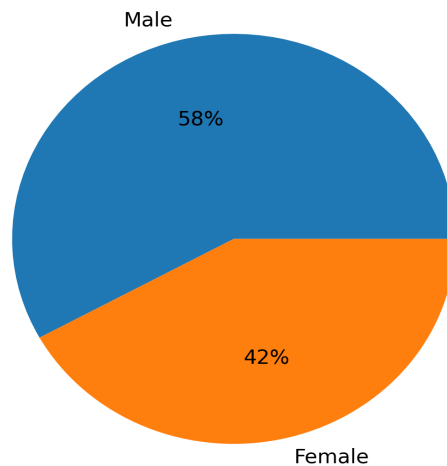


Figure 2: Gender Distribution of Study Population

3. Distribution of Respiratory Diseases

The pattern of respiratory diseases diagnosed among the pediatric patients is shown in Table 3. The most

common condition observed was acute respiratory infection (32%), followed by bronchial asthma (28%), bronchitis (22%), and allergic rhinitis (18%).

Table 3: Distribution of Respiratory Diseases

Respiratory Disease	Number of Patients	Percentage
Acute Respiratory Infection	32	32%
Bronchial Asthma	28	28%
Bronchitis	22	22%
Allergic Rhinitis	18	18%
Total	100	100%

The distribution of respiratory diseases among pediatric patients is represented graphically in Figure 3.

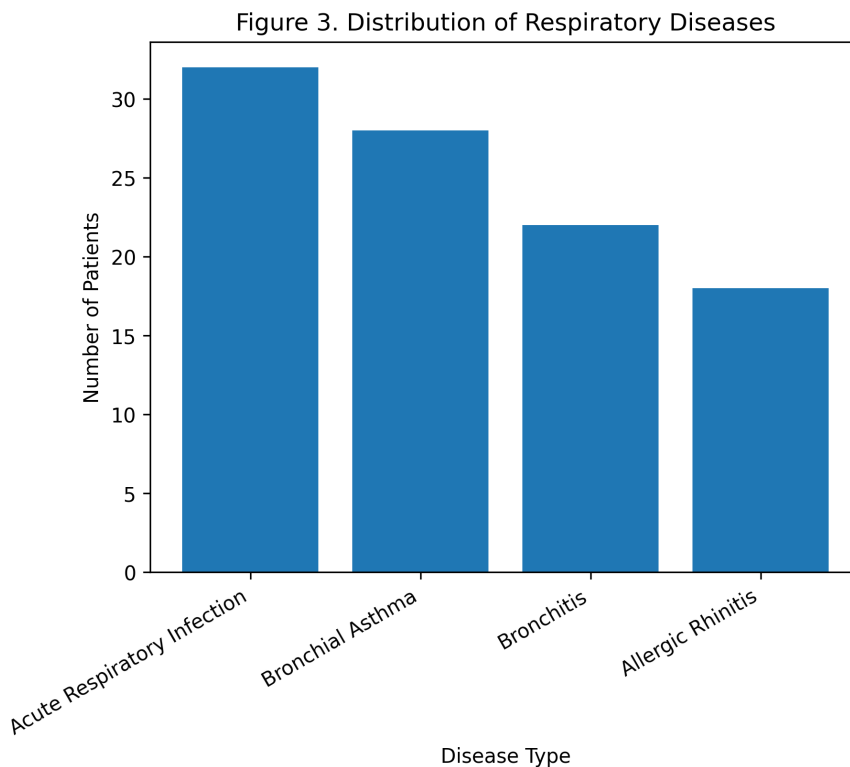


Figure 3: Distribution of Respiratory Diseases

4. Exposure to Environmental Pollution

Environmental pollution exposure among the study participants was categorized based on residential proximity to traffic areas, industrial zones, and parental smoking exposure.

Out of the total 100 children, 54 children were classified as having high pollution exposure, while 46 children had relatively lower exposure levels.

Table 4: Distribution of Pollution Exposure

Pollution Exposure Level	Number of Patients	Percentage
High Exposure	54	54%
Low Exposure	46	46%
Total	100	100%

The distribution of pollution exposure levels is shown in Figure 4.

Figure 4. Distribution of Environmental Pollution Exposure

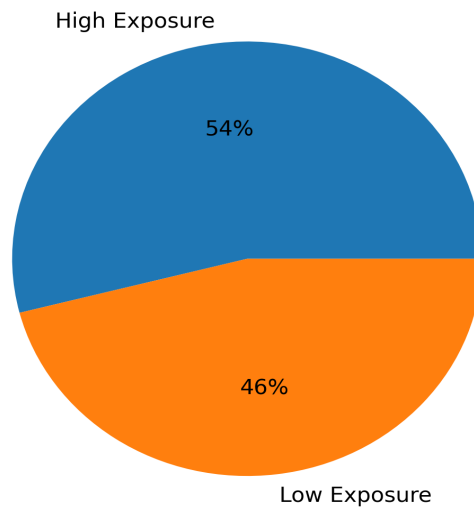


Figure 4: Distribution of Pollution Exposure

5. Association Between Pollution Exposure and Type of Respiratory Disease

The relationship between environmental pollution exposure and respiratory disease severity was analyzed using the Chi-square test.

Table 5: Association Between Pollution Exposure and Type of Respiratory Disease

Pollution Exposure	Acute Respiratory Infection	Bronchial Asthma	Bronchitis	Allergic Rhinitis	Total
High Exposure	20	16	10	8	54
Low Exposure	12	12	12	10	46
Total	32	28	22	18	100

The association between environmental pollution exposure and the pattern of respiratory diseases was analyzed using the Chi-square test. Children exposed to higher levels of environmental pollution showed a greater frequency of acute respiratory infections and bronchial asthma compared to those

with lower exposure levels. Statistical analysis demonstrated a significant association between pollution exposure and respiratory disease pattern ($\chi^2 = 8.62, p = 0.013$). This association is illustrated graphically in Figure 5.

Figure 5. Association Between Pollution Exposure and Type of Respiratory Disease.

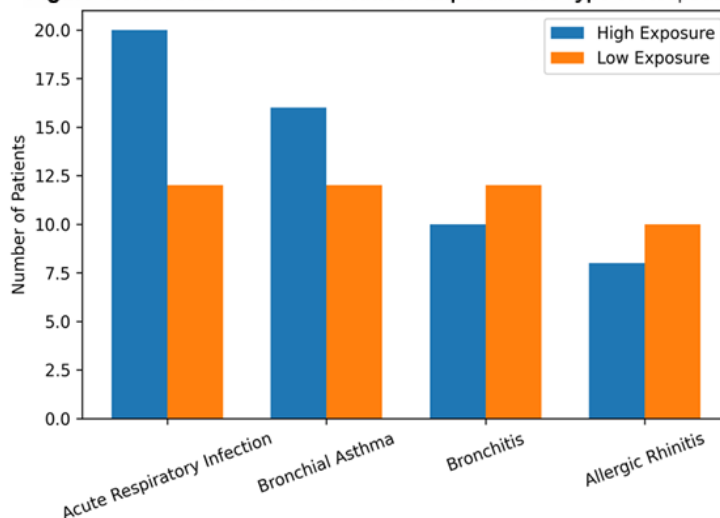


Figure 5: Association Between Pollution Exposure and Type of Respiratory Disease

Summary of Key Findings

The analysis of the study population revealed several important findings. The majority of pediatric patients belonged to the 6–10 years age group, accounting for 38% of the total cases, indicating that school-aged children were most frequently affected by respiratory illnesses in the present study. A male predominance was observed, with 58% of the patients being male and 42% female. Among the various respiratory conditions identified, acute respiratory infection was the most common diagnosis, representing 32% of the cases, followed by other conditions such as bronchial asthma, bronchitis, and allergic rhinitis. Assessment of environmental exposure showed that 54% of the children were categorized as having high exposure to environmental pollution, while the remaining participants had relatively lower exposure levels. Statistical analysis further demonstrated a significant association between environmental pollution exposure and the pattern of respiratory diseases, with a Chi-square (χ^2) value of 8.62 and a p-value of 0.013, indicating that children exposed to higher levels of pollution were more likely to develop respiratory illnesses.

Discussion

Environmental pollution is a major determinant of respiratory health, particularly among children. In the present study, the majority of patients were in the 6–10 year age group, which is consistent with previous epidemiological studies reporting increased exposure among school-aged children [19].

Male predominance observed in this study is comparable with findings reported by other researchers, suggesting possible behavioral and environmental factors influencing exposure patterns [20].

Acute respiratory infection was the most common condition identified in the present study. Similar findings have been reported in previous research, where respiratory infections accounted for a large proportion of pediatric hospital visits in polluted urban environments [21].

Bronchial asthma was the second most common condition, accounting for 28% of cases. Several studies have demonstrated that exposure to particulate matter and nitrogen dioxide significantly increases asthma prevalence and exacerbations in children [22].

Air pollution has been shown to cause airway inflammation and oxidative stress, resulting in increased respiratory symptoms and reduced lung function [23]. Long-term exposure to pollutants during childhood may impair lung growth and development.

The present study also demonstrated a significant association between environmental pollution exposure and the pattern of respiratory diseases among pediatric patients. These findings are consistent with global epidemiological studies linking air pollution with an increased risk of respiratory diseases among children.

Children exposed to higher pollution levels were more likely to develop respiratory symptoms including cough, wheezing, and breathlessness. These findings are supported by previous studies demonstrating a strong association between particulate matter exposure and respiratory symptoms in children [24].

Additionally, research has shown that children living near high-traffic areas experience higher rates of asthma and bronchitis due to increased exposure to traffic-related pollutants [25].

The results of the present study highlight the importance of environmental control measures and public health interventions to reduce pollution exposure among children.

Limitations

The present study has certain limitations that should be considered while interpreting the findings. First, it was conducted at a single tertiary care center, which may limit the generalizability of the results to other populations or geographic regions. Second, the sample size was relatively limited, as only 100 pediatric patients were included during the study period, which may reduce the statistical power of the study. Finally, the assessment of environmental pollution exposure was partly based on patient history and residential information provided by parents or guardians, which may introduce the possibility of recall bias or misclassification of exposure levels.

Conclusion

Environmental pollution plays a significant role in the occurrence and distribution of respiratory diseases among pediatric patients. Increased exposure to air pollutants is associated with higher prevalence of respiratory diseases such as asthma, bronchitis, and respiratory infections. Preventive measures and environmental policies aimed at reducing air pollution are essential to protect pediatric respiratory health.

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