

# Air Pollution, Its Health Effects on Residents of Patna: A Case Study <sup>†</sup>

Krishna Neeti, Mohammad Minhaj Faisal and Reena Singh \*

Department of Civil Engineering, National Institute of Technology Patna, Patna 800005, Bihar, India;  
krishnan.phd19.ce@nitp.ac.in (K.N.); mohammadf.pg21.ce@nitp.ac.in (M.M.F.)

\* Correspondence: reena@nitp.ac.in; Tel.: +91-9006463991

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**Abstract:** Air pollution is a serious issue in most parts of Bihar, especially in its capital city, Patna. The air quality in Patna has significantly worsened due to factors like rapid urbanization, increased traffic, and various natural and human-related causes. This decline in air quality has led to several negative health effects. In light of this, the aim of this study was to examine how air pollution affects the long-term health of Patna's residents, taking into account age and exposure time as important factors. We gathered data from one busy intersection in Patna, specifically Danapur. Health effects from air pollution were collected from the residents via a formatted questionnaire. To analyze the relationship between age, exposure time, and the health effects reported by the participants, we used a statistical test called the chi square test of independence. The findings of the study revealed a clear link between age, exposure time, and the health status of the participants. We concluded that older individuals and those with longer exposure times faced a higher risk associated with the increasing air pollution levels. This study provides a foundation for raising awareness among both authorities and the general public of the adverse health impacts associated with declining air quality, emphasizing the urgency in taking appropriate measures to counter this challenge.

**Keywords:** air pollution; short-term effects; long-term effects; chi square test; extrapolation; air quality forecasting



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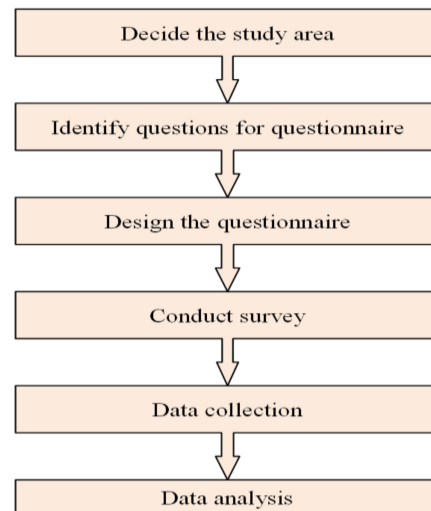
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## 1. Introduction

Bihar's capital city Patna, India, particularly bears the brunt of air pollution, a burgeoning concern across numerous regions worldwide [1]. Several factors, including rapid urbanization, an increase in vehicular traffic, and a blend of natural and anthropogenic sources, have resulted in significant deterioration of Patna's air quality [2]. Multifaceted challenges have been posed as a result of deteriorating air quality, especially in the context of public health. The purpose of this study was to examine the complex relationship between air pollution and well-being in Patna, especially regarding the effects over long periods of time, taking age and the exposure period into account [3]. The ambient air conditions were reflected in the data collected from the bustling district of Danapur Cantt within Patna. Through a meticulously designed questionnaire, we obtained firsthand accounts from the local population regarding the health effects associated with air pollution, in addition to objective data. A rigorous statistical framework was used to explore the intricate relationship between age, exposure duration, and health implications [4]. Among the analytical tools available, the chi square test of independence proved most effective in establishing patterns and correlations within the dataset. Based on the results of this comprehensive analysis, it was revealed that extended periods of exposure to high pollution levels are connected to an advancing age of individuals, further exposing their heightened vulnerability to health problems. There is an imperative need for strategic intervention, highlighting an imperative step toward resolving this complex challenge and enhancing Patna's well-being.

## 2. Method

The area selected for our study was Marshall Bazaar at Danapur Cantt. The area was so chosen as it usually had high vehicular density and had markets in and around it. A structured questionnaire was prepared, which was then used to collect data from individuals like auto rickshaw drivers, shop owners, vendors, etc., to assess the short-term and long-term effects of air pollution on their health. Figure 1 depicts the flowchart used in the study.



**Figure 1.** Flowchart used in the study.

## 3. Survey Data

Survey data were collected using a face-to-face interview method. The questionnaire is based on asking for age, exposure time, and the health problems they are facing. Health problems are of two types—short-term diseases, which include Headache, coughing, sneezing, ENT irritation, etc., while long-term diseases include Asthma, Bronchitis, Lung Cancer, and other respiratory problems. Table 1 depicts the Occurrence of diseases in people owing to Air pollution with their age as variable and Table 2 depicts the Occurrences of diseases in people owing to Air pollution with their exposure time as variable.

**Table 1.** Occurrences of diseases in people owing to Air pollution with their age as variable.

Headache						
Age Group	Never	Rare	Often	Frequent	Always	Total People Surveyed
15–30	4	6	7	6	8	31
31–45	9	5	3	8	7	32
46–60	3	2	2	10	8	25
>60	1	3	6	8	11	29
Total	17	16	18	32	34	117

ENT						
Age Group	Never	Rare	Often	Frequent	Always	Total People Surveyed
15–30	5	6	5	9	6	31
31–45	7	4	6	8	7	32
46–60	6	4	2	4	9	25
>60	6	2	5	6	10	29
Total	24	16	18	27	32	117

Table 1. Cont.

Respiratory Problem						
Age Group	Never	Rare	Often	Frequent	Always	Total People Surveyed
15–30	4	4	7	8	8	31
31–45	6	6	4	7	9	32
46–60	6	2	3	6	8	25
>60	3	4	5	9	8	29
Total	19	16	19	30	33	117

Asthma						
Age Group	Never	Rare	Often	Frequent	Always	Total People Surveyed
15–30	4	4	5	10	8	31
31–45	6	7	6	9	4	32
46–60	5	5	3	6	6	25
>60	5	3	5	7	9	29
Total	20	19	19	32	27	117

Bronchitis						
Age Group	Never	Rare	Often	Frequent	Always	Total People Surveyed
15–30	14	11	4	2	0	31
31–45	15	9	5	3	0	32
46–60	6	5	7	7	0	25
>60	10	8	6	5	0	29
Total	45	33	22	17	0	117

Lung Cancer						
Age Group	Never	Rare	Often	Frequent	Always	Total People Surveyed
15–30	31	0	0	0	0	31
31–45	32	0	0	0	0	32
46–60	25	0	0	0	0	25
>60	29	0	0	0	0	29
Total	117	0	0	0	0	117

Table 2. Occurrences of diseases in people owing to Air pollution with their exposure time as variable.

Headache						
Exposure Time	Never	Rare	Often	Frequent	Always	Total People Surveyed
0–30 min	3	9	5	6	1	24
30–60 min	6	7	4	5	3	25
1–2 h	5	5	2	8	6	26
2–4 h	2	4	3	6	5	20
>4 h	2	3	4	7	6	22
Total	18	28	18	32	21	117

ENT						
Exposure Time	Never	Rare	Often	Frequent	Always	Total People Surveyed
0–30 min	5	2	5	5	7	24
30–60 min	6	6	2	6	5	25
1–2 h	2	5	4	7	8	26
2–4 h	4	2	3	5	6	20
>4 h	3	4	4	7	5	22
Total	20	18	18	30	31	117

Table 2. Cont.

Respiratory Problems						
Exposure Time	Never	Rare	Often	Frequent	Always	Total People Surveyed
0–30 min	4	6	2	7	5	24
30–60 min	4	4	4	7	6	25
1–2 h	4	3	4	6	3	20
2–4 h	5	4	6	7	4	26
>4 h	3	6	3	6	4	22
Total	20	23	19	33	22	117
Asthma						
Exposure Time	Never	Rare	Often	Frequent	Always	Total People Surveyed
0–30 min	5	5	2	6	6	24
30–60 min	5	3	4	7	6	25
1–2 h	4	3	2	5	6	20
2–4 h	2	4	8	5	7	26
>4 h	3	2	4	6	7	22
Total	19	17	20	29	32	117
Bronchitis						
Exposure Time	Never	Rare	Often	Frequent	Always	Total People Surveyed
0–30 min	5	6	5	1	7	24
30–60 min	8	7	2	2	6	25
1–2 h	6	3	0	4	7	20
2–4 h	5	3	7	6	5	26
>4 h	4	2	1	6	9	22
Total	28	21	15	19	34	117
Lung Cancer						
Exposure Time	Never	Rare	Often	Frequent	Always	Total People Surveyed
0–30 min	24	0	0	0	0	24
30–60 min	25	0	0	0	0	25
1–2 h	20	0	0	0	0	20
2–4 h	26	0	0	0	0	26
>4 h	22	0	0	0	0	22
Total	117	0	0	0	0	117

#### 4. Results and Discussions

In this paper, the effect of air pollutants on human health is studied. For this purpose, initially the air quality parameter of the busy business location of Patna was observed. The commonly observed diseases owing to air pollution are taken from the literature, and the health of people affected due to their exposure to the environment is studied through a structured questionnaire.

Table 3 depicts the Diseased (Long-term) and healthy people in different age groups as per survey.

##### Long-Term Diseases

The chi square test of independency was adopted to check the dependency of long-term disease with age [5]. When the frequencies of the two data groups are known, the chi square test is the best-suited method to check the dependency between the given data.

To check the dependency of long-term disease with age, two hypotheses were assumed:

**H0.** *There is no relationship between health of people and age.*

**H1.** *There is a relationship between health of people and age.*

**Table 3.** Diseased (Long-term) and healthy people in different age groups as per survey.

Age (in yrs.)	Diseased	Healthy
15–30	47	14
31–45	42	22
46–60	32	20
>60	41	17

Using chi square test of independence,  $p$  value = 0.2924. As  $p$  value > 0.05, the null hypothesis is rejected. Thus, occurrence of long-term diseases is dependent on the age group of individuals.

## 5. Conclusions

In all cases, the  $p$  value using the chi square test of independency is >0.05. As a result, the null hypothesis is rejected. Thus, the occurrence of both short-term and long-term diseases is dependent on the age as well as exposure time of individuals.

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