IMPACT OF AIR POLLUTION ON HUMAN HEALTH IN DEHRA DOON CITY

by

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I. INTRODUCTION

Air quality affects human health. Nearly 1.4 billion urban residents in the world breathe air that fails the WHO air quality standards.[1] At the global level, mortality due to exposure to outdoor air pollution is estimated to range from 200,000 to 570,000.[2] In Indian cities, among the most polluted in the world, available mortality and morbidity statistics indicate that respiratory infections and chronic conditions are widespread.[3]

Dehra Doon city is situated in a valley, located between the outer Himalaya and Shivalik ranges. Very little air circulates in or out of this region and the pollutants remain trapped near the ground level. Owing to its unique physiography, Doon valley has been declared as an 'Ecologically Fragile Zone' under the provisions of the Environmental (Protection) Act, 1986 and the Uttar Pradesh Special Area Development Act, 1986. [4]

The major source of air pollution in Dehra Doon is vehicular traffic, which emits particulate matter, sulphur dioxide, nitrogen oxides, carbon monoxide, hydrocarbons, etc. Particulate matter, the main atmospheric pollutant, can have severe health effects. Air pollution episodes in Muese Valley (1930), Donora (1948) and the London fog of 1952 resulted in heavy mortality.[2] These events indicate that short term elevated levels of particulate matter and sulphur dioxide can lead to a variety of pulmonary disorders including mortality. Respirable particulate matter (RPM) is a respirable fraction with a diameter of less than 10 micron. It enters the respiratory system and is responsible for a number of upper respiratory ailments like runny nose, sinusitis, sore throat and wet cough as well as lower respiratory symptoms such as wheezing, dry cough, phlegm, etc.[2] Increased particulate exposure can lead to diseases like bronchitis, pneumonia and cardiovascular problems. Certain air borne particles like arsenic, chromates, particles bearing PAHs, radioactive particles can cause carcinoma of lung tissues.[5] Fine particles, with an aerodynamic diameter of below 2.5 microns, on inhalation enter up to the alveoli and obstruct gas exchange processes of respiration. [2] For every 10 ug/m^3 increase in RPM, the following changes have been recorded in several epidemiological studies: (i) Increase in total mortality by 1%, (ii) Rise in cardiovascular mortality by 1.4%, and (iii) Increase in respiratory mortality by 3.4 %. [5]

In a recent study, residents of Kolkata displayed substantial increase in symptoms of upper and lower respiratory tract diseases as compared to people living in the rural areas. Respiratory symptoms were most frequent during winter when the pollution level of the city with respect to RPM was the highest. [6] The All India Institute of Medical Science (AIIMS) conducted a health survey in 1997-98 on individuals residing in the residential areas of Delhi. It was reported that air pollution led to irritation of the eyes (affecting about 44.4% of the subjects surveyed), cough (28%) and respiratory problems (5.9%).[7] Another study carried out in Delhi found that haze caused by pollutants significantly reduced ultraviolet (UV-B) rays available to synthesise vitamin D. Children living in more polluted areas had less than half the vitamin D in their blood than those living in less polluted areas.[8]

Sulfur dioxide (SO_2) and nitrogen

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oxides (NO_X) can have adverse effects on human health as well. Exposure to even low levels of SO_2 is known to affect breathing.[2] It causes irritation by stimulating nerves in the lining of the nose, throat and the lung airways. Long exposure can cause upper and lower respiratory diseases, increase in rates of cough, bronchitis and asthma. NO_X can cause breathing difficulties like bronchitis, emphysema.[2] Higher exposure may lead to dysfunctioning of the immune system.

There is a definite correlation between environmental exposure and health status. The main factors which regulate occupational health status, are: [9]

1. Nature and substance of exposure
2. Intensity or severity of exposure
3. Length of exposure
4. Personal susceptibility

Acute Effects

Acute effects are immediate and short-term effects on the body. The effects of irritant particles in the respiratory tract depend upon their solubility, size, their penetration, deposition and clearance mechanisms in the respiratory tract. Fine particles may cause bronchospasm, pulmonary oedema and allergic alveolitis. Three types of acute effects which may result from inhalation of gases and vapors are asphyxiation, irritation of respiratory organs and harcosis. Other acute effects of particulate air pollution are stuffy or runny nose, sinusitis, sore throat, wet cough, head cold, hay fever and burning or red eyes. [5]

Chronic Effects

Chronic effects are long-term ailments due to a certain trigger. Chronic Obstructive Pulmonary Diseases (COPDs) include bronchitis or emphysema, which are long term and serious conditions. More typical chronic responses include damage to lungs, to blood, nervous system, liver, kidneys, bones and skin. [5]

The objective of the present study were:

- To study the adverse health effects of exposure to ambient air pollution in different areas of Dehra Doon.
- To examine the relationship between the levels of air pollution and the percentage of affected people in selected area of Dehra Doon city.

II. METHODOLOGY

Study area

Air quality monitoring and a questionnaire-based health survey in four areas of Dehra Doon were conducted during January and February 2003. The selected areas included two commercial areas, Lakhi Bagh and Clock Tower, both with highly congested vehicular traffic. For comparison two residential areas, Vasant Vihar and Kedarpuram were also studied. Kedarpuram is a less urbanised but a medium density area compared to Vasant Vihar.

Air quality monitoring

The monitoring of air pollutants in the present study was undertaken at 4 stations of which two were primarily commercial and the other two were residential areas. Every sampling day, twenty-four hours sampling was done. At each sampling sites two samples were collected in a month in the first and the second half of the month. It was done in three months of winter (2002 – 03). The parameters were (i) RPM, (ii) TSPM (Total Suspended Particulate Matter), (iii) NO_x and (iv) SO_2. They were analyzed as per the IS: 5182 guidelines.

Health survey-

A survey of 519 individuals was conducted in the selected areas. Local residents, shopkeepers, hawkers, autorickshaw drivers, etc. were asked to list the occurrence of respiratory problems like cough, dry cough, cold, runny nose, nose block, bronchitis, wheezing, pneumonia and asthma along with eye problems, skin diseases and heart diseases. Information regarding respondent's age, sex, occupation, income, residence, food habits, etc. was also collected for subsequent analysis. The number of respondents in the four sites is given in Table 1.

Table 1: No. of respondents in different study sites

Sl. No.	Study site	No. of respondents
1	Lakhi Bagh	148
2	Clock Tower	125
3	Kedar Puram	119
4	Vasant Vihar	127

III. RESULTS AND DISCUSSION

Air Quality

Air quality data are presented in Table 2. It shows the average concentrations of RPM, TSPM, NO_X and SO_2. The RPM concentrations exceeded the CPCB prescribed standards in both the commercial areas of Lakhi Bagh and Clock Tower, whereas it was alarmingly high in the residential areas of Kedar Puram and Vasant Vihar.

Health Effects

Information was collected from the respondents about the incidence of eye problems, acute and chronic respiratory diseases and skin diseases. In many cases incidence of multiple diseases in a single respondent was reported. Table 3 presents an account of the percentage occurrence of various diseases in respondents interviewed at the different study locations.

A comparison of the average percentage disease occurrence (APDO) in the commercial areas (with high concentrations of air pollutants) and the residential areas (with low concentrations of air pollutants) is presented in Table 4. It shows that for every ailment, except the chronic ones – bronchitis and asthama, the APDO is significantly higher in the commercial areas, with higher concentrations of air pollutants, than in the residential areas. Since the main source of the pollutants in the commercial areas is motor vehicular traffic, there is a clear need to decongest such traffic in these areas.

A survey of exposure to air pollution and its consequent health effects done in Mumbai in 1996 by IIT-Bombay and CPCB reported findings of a similar nature.[10] The maximum number of respondents suffering from chronic cough were from the high pollution areas (18.4%), followed by those living in medium pollution zones (10.2%) and finally the low pollution zones (6.9%)

Table 2: Ambient air quality in different areas of Dehra Doon in **winter** (2002 – 03)

S.No.	Stations	Pollutants in µg/m^3			
		RPM	**TSPM**	**NO_x**	**SO_2**
1.	Lakhi Bagh	217	608	78	31
2.	Clock Tower	148	444	58	25
3.	Kedar Puram	96	182	24	13
4.	Vasant Vihar	77	148	20	9
CPCB Standard*		**100**	**200**	**80**	**80**

* Source : CPCB, National Ambient Air Quality Monitoring Series, NAAQMS/22/2001-02.

Table 3: Percentage of respondents reporting specific ailments

Sl.No.	Disease	Lakhi Bagh	Clock Tower	Kedar Puram	Vasant Vihar
1.	Eye problems	46.6	38.4	12	15
2.	Cough	46.6	42.4	26	34
3.	Dry cough	13.5	12	1.7	3.9
4.	Sneezing	26.7	24.8	12	15
5.	Nose block	22.3	18.4	13	11
6.	Running nose	11.5	13.6	5	9.4
7.	Wheezing	20.9	16	12.5	11.1
8.	Bronchitis	8.1	7.2	3.3	6.3
9.	Asthma	4.1	1.6	2.5	1.6
10.	Skin disease	4.7	10	1.7	0.6
Total number of respondents		**148**	**125**	**119**	**127**

Table 4: Comparison between commercial and residential areas disease patterns.

Sl. No.	Diseases	APDO* in commercial areas with high level of air pollution (%)	APDO* in residential areas with low level of air pollution (%)
1	Eye problems	43	14
2	Cough	45	30
3	Sneezing	26	14
4	Nose block	20	12
5	Wheezing	19	12
6	Dry cough	13	3
7	Running nose	13	7
8	Bronchitis	8	5
9	Asthma	3	2
10	Skin diseases	7	1

*APDO – Average Percentage Disease Occurrence

Table 5 shows the association between the concentrations of different air pollutants and the percent incidence of diseases in terms of the value of the coefficients (R) between them. The degree of association between the different air pollutants and the disease occurrence on the basis of the value of the coefficient of correlation (R) is presented in the Table 6.

Tables 5 and 6 clearly show that eye and acute respiratory ailments, except runny nose, correlate strongly with all the air pollutants studied. Chronic ailments like bronchitis, asthama and skin diseases, however, have a lower correlation with motor vehicular air pollutants. This is not surprising since the longer term diseases are most likely influenced by other factors as well.

Table 5: Coefficient of correlation (R) between specific air pollutants and illnesses.

S.No.	Diseases	Ambient air pollutants			
		RPM	**SPM**	**NO_x**	**SO_2**
1.	Eye problems	0.94	0.98	0.99	0.97
2.	Cough	0.85	0.90	0.91	0.86
3.	Dry cough	0.90	0.96	0.96	0.94
4.	Sneezing	0.87	0.94	0.94	0.92
5.	Nose block	0.98	0.99	0.99	0.99
6.	Running nose	0.58	0.70	0.71	0.67
7.	Wheezing	0.99	0.98	0.98	0.97
8.	Bronchitis	0.71	0.77	0.77	0.71
9.	Asthma	0.77	0.66	0.65	0.63
10.	Skin disease	0.54	0.66	0.67	0.71

Table 6: Categorisation of values of coefficient of correlation (R) between air pollutants and illnesses.

Sl. No.	**Degree of association (R)**	**Diseases associated with RPM**	**Diseases associated with TSPM**	**Diseases associated with NO_x**	**Diseases associated with SO_2**
1	Excellent ($R > 0.9$)	Eye problem Nose block Wheezing	Eye problem Dry cough Sneezing Nose block Wheezing	Eye problem Cough Dry cough Sneezing Nose block Wheezing	Eye problem Dry cough Sneezing Nose block Wheezing
2	Very Good ($0.8 \leq R \leq 0.9$)	Cough Dry Cough Sneezing	Cough	-	Cough
3	Good ($0.7 \leq R \leq 0.8$)	Bronchitis Asthma	Bronchitis Runny Nose	Bronchitis Runny Nose	Bronchitis Skin disease
4	Fair ($R < 0.7$)	Runny Nose Skin disease	Asthma Skin disease	Asthma Skin disease	Runny Nose Asthma

IV. CONCLUSIONS

The results of the epidemiological study indicate that air pollution in Dehra Doon city is seriously affecting the health of the people, especially in Lakhi Bagh and Clock Tower, which are most polluted by motor vehicular traffic. Eye diseases and acute respiratory illnesses correlate strongly with air pollution levels. Chronic diseases have a lower correlation than acute illnesses with air pollution in Dehra Doon. There is thus a serious need to reduce traffic congestion in Dehra Doon's commercial areas.

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