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RESEARCH ARTICLE

AIR POLLUTION AND ITS IMPACT ON HUMAN HEALTH IN PANIPAT CITY OF HARYANA, INDIA

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Abstract

The results indicate that ambient air quality in the commercial zone is affected adversely due to emission and accumulation of SPM, RSPM, SO_2 and NO_x as, compare to residential zone. The data reveals a significant increase in the total number of study population suffering from eye diseases, 44% observed in commercial zone and 13.5 % in residential zone. For acute respiratory illnesses (correlate strongly with air pollution levels) the higher number of study population suffering in commercial zone (cough 45.20%, Sneezing 26.75%, Nose block 21.20%, Wheezing 19.55%, Dry cough 13.75%, Bronchitis 7.67%, Asthma 3.95%) as to compare residential zone (cough 13.5%, Sneezing 14.0%, Nose block 13.0%, Wheezing 12.0%, Dry cough 6.80%, Bronchitis 4.3%, Asthma 0.88%) during winter 2010. The average percentage disease occurrences (APDO) observed higher in commercial zone due to high concentrations of air pollutant and lower in residential zone to low concentrations of air pollutants.

Introduction

Panipat is situated on Shershah Suri Marg (now known as G.T. road or NH-1), 90 KM north of Delhi. On three sides, Panipat district boundaries touch other districts of Haryana Karnal in the north, Jind in the west and Sonipat in the south. Panipat also has heavy industry with include three major public sector projects: the Indian Oil Corporation oil refinery, the National Fertilizers Limited plant and the thermal power station and the biggest centre in the country for producing shoddy (recycled) yarn, a large consumer of rags for reprocessing and producing low priced blankets. A traditional supplier of barrack blankets to the armed forces. Biggest centre in the country engaged in export of cotton durries, made-ups, throws and mats. Samalkha, a small town near Panipat, is known for foundry work and supply of agricultural machinery to neighboring Uttar Pradesh. Relatively high wages compared to the Indian national average – a worker earns Rs.300/-to 450/- per day on Handloom/ Powerloom. The town has infrastructure such as rail, road and inland container depots well suited to industry and export. The main source of air pollution is heavy traffic load of NH-1 highway and uncontrolled exhaust smoke release by vehicles and Industries.

The impact of industrial and vehicle pollution on human health in urban areas is at peak level as vehicle emissions are near the ground level where people live and work. Diesel exhaust, in addition to generating pollutants like hydrocarbons, oxides of nitrogen and carbon is a major contributor to particulate matter in most places of the world. Symptoms like chronic cough, wheezing and breathlessness have been reported on exposure to these pollutants (Chabra et al., 2001). The respirable particles are responsible for the cardiovascular as well as respiratory diseases (Sagai et al., 1996) of human being because these particles can penetrate deep into the respiratory system, and studies indicates that the smaller the particle, more severe the health impacts (Dockery et al., 1993; Pope et al., 1995; Schwartz et al., 1996). Ambient particulate matter may be carriers of acidic or toxic species (e.g., heavy metals, acids and carcinogenic organic compounds) and may have detrimental effects on human health and ecosystems. Besides the effect of particulate matter, literature also suggests that there is a strong relationship between higher concentration of SO2 and NOx and several health effects (Curtis et al., 2006), like cardiovascular diseases (Zanobetti and Schwartz, 2002; Peters et al., 2004; Chen et al., 2005; Dockery et al., 2005) respiratory

health effects such as asthma and bronchitis (Ye et al., 2001; Barnett et al., 2005) and reproductive and developmental effects such as increased risk of preterm birth (Liu et al., 2003). 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, and 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 (Dockery D.W and Pope C.A. III, 1994). 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 (Dockery D.W and Pope C.A. III, 1994).

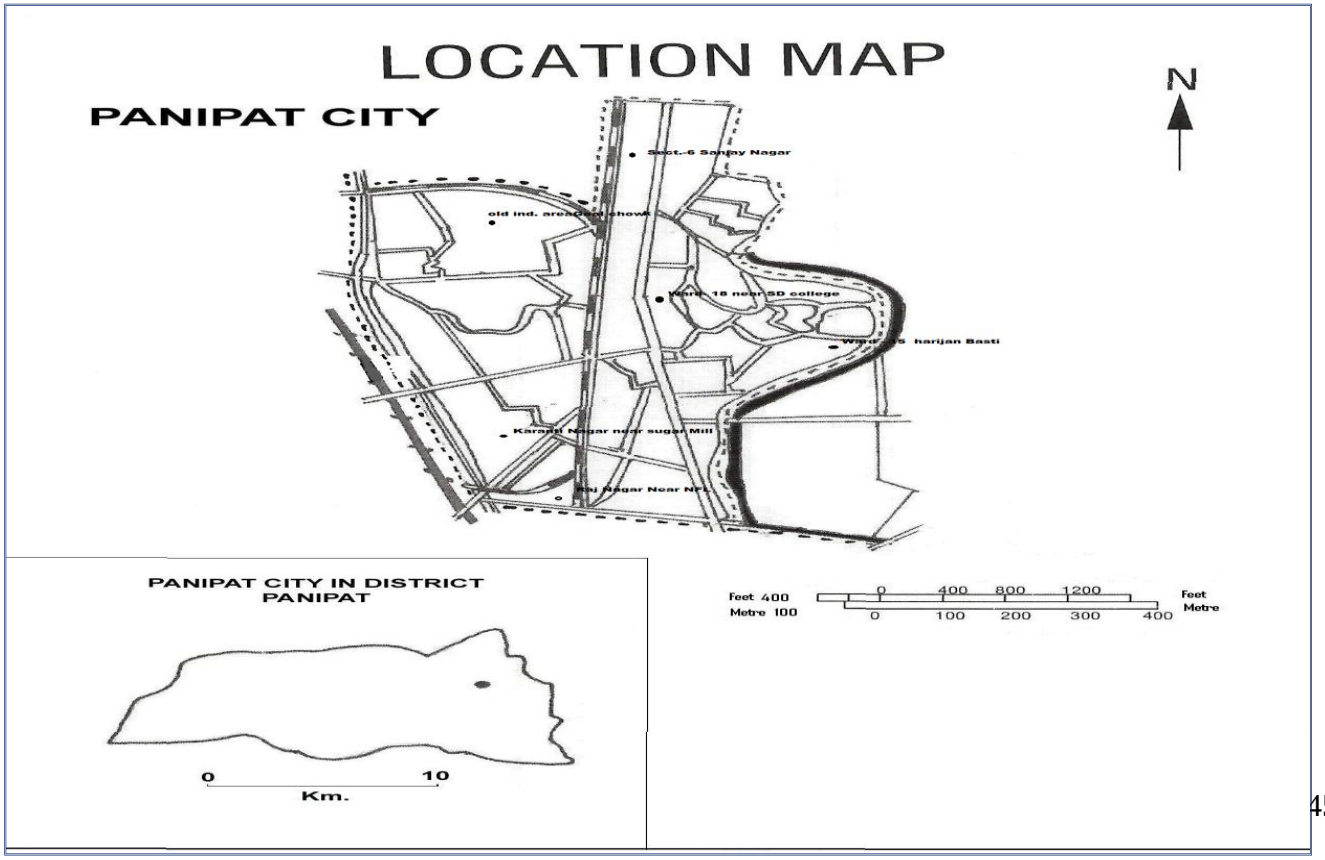
The objective of the present study was to cheek the adverse health effects of exposure to ambient air pollution in different areas of Panipat City of Haryana and examine the relationship between the levels of air pollution in Industrial areas as well as residential zone. The reasons for faster urbanization of Panipat city may be due to its being very near to Delhi. Panipat has seen tremendous increase of industries with uncontrolled exhaust. Air pollution in Panipat city is increasing day by day due to vehicular exhausts. Hence ambient air quality of the city and impact on human health has been monitored and was to cheek the adverse health effects of exposure to different pollutants in the present study.

2. MATERIAL OF METHODS

2.1 Site specifications:

Panipat city (city of textiles and carpets) is a fast developing city of Haryana state, India located at 29.39°N 76.97°E in 90 KM north of Delhi. It is the biggest centre for quality blankets and carpets in India and has a handloom weaving industry. Panipat also has heavy industry; with include Indian Oil Refinery, National Fertilizers Limited and Thermal Power Station. Keeping of these points we are monitoring of SPM, RSPM, SO2 and NOx of Panipat city were selected for the ambient air quality (Fig.1), which have observed considerable growth in commercial zone during last few years. A total of four sampling sites were selected on the bases of differential population activity and characteristics which has been divided into two zones namely residential zone (R), Sector 24, HUDDA and Sector 7, HUDDA) and commercial zone (C) Lord Shiva Woolen Mills and Pan Foods Ltd. G.T. Road.

Figure-1: Panipat city map with sampling locations



2.2 Air quality monitoring and analysis:

Air monitoring was conducted during winter seasons January, 2010 to March, 2010 for 24 hrs of SPM, RSPM, and 8 hrs for SO_2 and NO_X. APM-460 respirable dust samplers (RDS) with provision for gaseous sampling APM-415 (Envirotech, New Delhi) was used for measuring the concentrations of SPM, RSPM, NO_x and SO_2 in the ambient air. The sampling inlet was placed 1-3 meter above the ground level, depending upon the site available for the RDS. The APM-460 Respirable Dust Sampler has been provided with a cyclone. The cyclone has been designed to provide separation of RSPM particles. Atmospheric air was drawn for ~24 hours through the cyclone and 20 X 25 cm glass fiber filter (GFF) sheet at a flow rate of 1.0 to 1.2 m^3min^{-1} and finally the average flow rate was calculated.

2.3 Air quality index (AQI):

The Air Quality Index (AQI) was calculated using the method suggested by Tiwari and Ali (1987) and followed by Kaushik et al., (2006). For AQI, the air quality rating of each pollutant was calculated first by the following formula.

$$Q = 100 \frac{V}{VS}$$

Where, Q represents quality rating, V the observed value of the pollutant and Vs the standard value recommended for that pollutant. The Vs values used are the recommended National Ambient Air Quality Standards (CPCB-1994) for different areas (Table 2).

2.4 Health risk analysis:

The health risk analysis was conducted in residential and commercial zone study population (n=525) individuals, in which some are local residents, shopkeepers, hawkers, auto rickshaw drivers are expends at least 12 hrs times in a day in these study areas due to their residence, to perform duties, business work and others reasons (Table 3).

Data collection has been done by the 'Questionnaire method', covering various households. All aspects of environment of each household, like socio- economic status, age, sex, occupation, indoor air pollution, vehicular pollution, sanitation, quality of drinking water and diseases like respiratory, gastrointestinal, eye diseases, skin problems, water/vector bornediseases, cardiovascular and miscellaneous ones have been taken into consideration. For the documentation of information regarding specific health end points such as respiratory ailments, infectious diseases, cardiovascular problems which belong to the area under study (Table 4). Considering NAAQS as a standard we perform the comparison of the average percentage disease occurrence (APDO) in the commercial zone (with high concentrations of air pollutants) and the residential zone (with low concentrations of air pollutants) is presented in Table 5.

3. RESULTS AND DISCUSSION

3.1 Site specific variations an air monitoring.

In residential zone, the average concentration of SPM and RSPM, were found to be 197.7 (196.7-198.7) and 79.98 (65.1-94.8) $\mu g/m^{-3}$ respectively whereas, in commercial zone, the average concentration of SPM and RSPM, were found to be 605.0 (558.7-652.0) and 377.4 (319.0-435.0) $\mu g/m^{-3}$ respectively (Table 1). The mean concentration of air pollutants (SPM, RSPM) found in the reducing order of residential zone < commercial zone.

Gaseous pollutants (SO_2 and NOx) were found to be 13.5 (10.2-16.8), 19.75 (15.5-24.0) $\mu g/m^{-3}$ in residential zone whereas, 22.1 (21.2-23.0) and 31.2 (30.0-32.5) $\mu g/m^{-3}$ respectively found in commercial zones, which is found below the permissible limits at all sites of Panipat city.

The 24 hr mean concentration of SPM and RSPM, at all the locations in commercial zone were found higher than the respective prescribed National Ambient Air Quality Standards (NAAQS). On the other hand the Air Quality Index (AQI) based on the calculation of 24 hr average concentration of SPM, RSPM, SO_2 and NOx at different locations showed to polluted (V) category at all the commercial zone, whereas, the residential zone showed fairly clean (III) for residential sector 24, HUDDA and clean (II) category in residential sector 7, HUDDA (Table 2). Higher index values indicate higher health risks and maximum value was found in the commercial area. Urban air pollution due to vehicular emission is a matter of concern because of exposure of large number of people to it. Vehicular emission is responsible for higher level of air pollutants like SPM, RSPM, SO2, NOx and other organic and inorganic pollutants including trace metals and their adverse effects on human and environmental health (Caselles et al., 2002; Kaushik et al., 2006; Maitre et al., 2006 ; Curtis et al., 2006; Sharma et al., 2006; Jayaraman, 2007). The only industrial area showed fairly clean category because of higher NAAQS. The concentration of RSPM at all the commercial and residential zone showed higher than the permissible values and based on AQI, all the locations are either in polluted or moderately polluted category and might be due to the harmful effect of the RSPM dwelling in the area.

3.2 Air quality index (AQI):

The air quality index is a tool used by EPA (2000), CPCB (1994) and other agencies to provide the public with timely and easy-to-understand information on local air quality and whether air pollution levels pose a health concern. In the present investigation, the SPM, RSPM, SO_2 and NO_X level in Panipat city have been calculated. The higher value (above 125) of an index refers to a great level of air pollution (Severely Polluted) and consequently greater health risks. The categorization of ambient air quality with respect to the AQI is presented in Table 2. On the basis of AQI, it can be seen that the commercial zone (C) were showed to category (V) to polluted (AQI 75-100) in both site whereas, the residential zone (R), on an average, lie in the range of category (II) to clean (AQI 10-25) in sector 7 HUDDA and to fairly clean (AQI 25-50) category in sector 24 HUDDA.

Table 1: Mean value of ambient air concentration (µg m^{-3}) of air pollutants (SPM, RSPM, SO_2 and NO_x) in winter season and air quality index (AQI) for different locations of Panipat city.

Air Monitoring Study Zone	Air Monitoring Study Sites	Pollutants in µg m^{-3}				AQI Category
		RSPM	SPM	NO_x	SO_2	
Commercial zone (C)	Lord Shiva Woolen Mills	319.10	652.40	32.5	21.2	**V**
	Pan Foods Ltd.	435.70	558.70	30.0	23.0	**V**
Residential zone (R)	Sector 24, HUDDA	65.10	196.70	24.0	16.8	**III**
	Sector 7, HUDDA	94.85	198.70	15.5	10.2	**II**

Table 2: Air quality categories based on AQI.

AQI of ambient air	Category	Description of ambient air quality
Below 10	I	Very clean
Between 10-25	II	Clean
Between 25-50	III	Fairly clean
Between 50-75	IV	Moderately polluted
Between 75- 100	V	Polluted
Between 100-125	VI	Heavily polluted
Above 125	VII	Severely polluted

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

Table 3: Data on study population (n=512) at different study zones and sites in Panipat city.

Study zone	Study sites	No. of sample (n=525)	Age Group (Years)	Occupation
Commercial zone (C)	Lord Shiva Woolen Mills	150	18-60	local residents, shopkeepers, hawkers, auto rickshaw and drivers
	Pan Foods Ltd.	130	18-60	local residents, shopkeepers, hawkers, auto rickshaw and drivers
Residential zone (R)	Sector 24, HUDDA	125	18-60	local residents, shopkeepers, hawkers, auto rickshaw and drivers
	Sector 7, HUDDA	120	18-60	local residents, shopkeepers, hawkers, auto rickshaw and drivers

Table 4: Data in percentage of study populations (n=525) with respiratory ailments, infectious diseases and others specific ailments in Panipat city.

S.No.	Disease	Commercial zone (C)		Residential zone (R)	
		Lord Shiva Woolen Mills	Pan Foods Ltd.	Sector 24, HUDDA	Sector 7, HUDDA
1.	Eye problems	47.6	40.4	14.0	12.0
2.	Cough	48.0	42.4	28.0	32.0
3.	Dry cough	13.5	14.0	7.7	5.9
4.	Sneezing	26.7	26.8	15.0	13.0
5.	Nose block	24.0	18.4	15.0	11.0
6.	Running nose	11.5	13.6	5.2	4.9
7.	Wheezing	20.9	18.2	14.5	8.1
8.	Bronchitis	8.1	7.2	4.3	4.3
9.	Asthma	6.1	1.8	2.8	1.6
10.	Skin disease	4.7	10.0	1.7	0.6
Total number of study populations (n=525)		**150**	**130**	**125**	**120**

Table 5: A comparative analysis between Commercial Zone (C) and Residential Zone (R) study population's disease patterns in Panipat city.

S. No.	Diseases	APDO* in commercial zone with high level of air pollution (%)	APDO* in residential zone with low level of air pollution (%)
1	Eye problems	44.0	13.50
2	Cough	45.20	30.0
3	Sneezing	26.75	14.0
4	Nose block	21.20	13.0
5	Wheezing	19.55	12.0
6	Dry cough	13.75	6.80
7	Running nose	12.55	5.05
8	Bronchitis	7.65	4.30
9	Skin diseases	7.35	1.15
10	Asthma	3.95	0.88

*** NAAQS as a standard of comparison of the Average Percentage Disease Occurrence (ADPO)**

3.3 Health risk study of Panipat city

The most common sources of air pollution include particulates, ozone, nitrogen dioxide, and sulfur dioxide. Both indoor and outdoor air pollution have caused approximately 3.3 million deaths worldwide. Children aged less than five years that live in developing countries are the most vulnerable population in terms of total deaths attributable to indoor and outdoor air pollution (WHO, 2011). The World Health Organization states that 2.4 million people die each year from causes directly attributable to air pollution, with 1.5 million of these deaths attributable to indoor air pollution (WHO, 2002) Epidemiological studies suggest that more than 500,000 Americans die each year from cardiopulmonary disease linked to breathing fine particle air pollution (Charmayne et al, 2008). A study by the University of Birmingham has shown a strong correlation between pneumonia related deaths and air pollution from motor vehicles. Worldwide more deaths per year are linked to air pollution than to automobile accidents (Collins, 2012). Results of present study revealed that higher level of particulate matter especially the RSPM, is more dangerous for human health and responsible for several cardiovascular and 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 was collected through questionnaire from the study population (n=525) about the incidence of eye problems, acute and chronic respiratory diseases and skin diseases. In many cases incidence of multiple diseases in a single person was reported. Table 4 presents an account of the percentage occurrence of various diseases in study population (n=525) interviewed at the different study locations. Keeping in view this fact and considering NAAQS as a standard we perform the comparison of the average percentage disease occurrence (APDO) in the commercial zone (with high concentrations of air pollutants) and the residential zone (with low concentrations of air pollutants) is presented in Table 5. It shows that for every ailment, except the chronic ones – bronchitis and asthma, the APDO is significantly higher in the commercial zone, with higher concentrations of air pollutants, than in the residential zone. Since the main source of the pollutants in the commercial zone is motor vehicular traffic as well as smoke release to thermal, Refinery and NFL, there is a clear need to decongest such traffic in these areas. Similar study was done in 1996 in Mumbai in which, the exposure to air pollution and its consequent health effects by IIT-Bombay CPCB reported findings of a similar nature (Ghosh C.2001). The maximum number of respondents suffering from chronic cough was 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%). The results of the present study were compared with earlier study during pre monsoon, 2005 (ITRC report 2005; Sharma et al., 2006) during the year 2005 and it was found that the average concentration of air pollutants like SPM and RSPM at ten locations of urban area, showed slightly higher value in commercial zone as compare to residential zone in 2006. Though the mechanisms are not fully explained, epidemiological evidence suggests that outdoor air pollution is a contributing cause to morbidity and mortality (Bates, 1992; Katsouyanui et al.; Kunzli et al., 2000). State-of-the-art epidemiological research has found consistent and coherent associations between air pollution and various symptoms. Most of the air pollution studies have been conducted in the developed countries. Epidemiological data on the health effects of air pollutants are not abundant for most of the developing countries, where a major proportion of the population lives in environmentally poor conditions. The results of the epidemiological study indicate that air pollution in Panipat city of Haryana is seriously affecting the health of the people, especially lived in commercial zone as compare to people lived in residential zone. Increased day by day air pollution is a serious problem and need to immediate reduce traffic congestion in Panipat commercial zone.

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