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Case Study

Concentration of Convention Pollutants and Human Health – A Case Study

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A B S T R A C T

Unpleasant fumes and odors, reduced visibility, injury to human health, crops and forms of vegetation by noxious pollutants and damage to property by dust particle and corrosive gases rank among the major environmental problems of urban and industrialized areas and their surroundings. The fact was true with Visakhapatnam (17°42¹ N; 82°8¹E) a highly industrialized coastal metropolitan city on the east coast of India. Respiratory problems among children, especially in the age group of 5 to 15 years, are escalating largely due to various forms of pollutions. The open dumping of coal and other bulk cargo by Visakhapatnam Port Trust that is creating major health problems. In some of the areas in Visakhapatnam the values of SPM and RPM are exceed 20 to 40 % more. Children's are suffering not only asthma, they are also suffering from various kinds of respiratory diseases and lung disease as the pollutants and dust particles enter the body's respiratory system and mix with blood stream. Generally the asthma attacks during winter season due to dryness in the atmosphere and increased irritation to respiratory mucus. Incidence of Asthma is on the increase in the port city. It is interesting to note that suffering population include young one. The rising pollution levels in Visakhapatnam coupled with the dipping mercury levels have resulted in a sharp increase in number of children suffering from various respiratory problems. The admission in hospital rate was highest in the 15-49 age groups and lowest in 0 - 4 age group due to asthma and bronchitis.

Introduction

Visakhapatnam is one of the 10 major ports in India is located on the East Coast about 880 km South West of Calcutta and 780 km North East of Chennai by rail. Extending along the shore of a wide bay, on the Bay of Bengal and surrounded by a picturesque amphitheater of hills. The city is surrounded by (i) two hill ranges bordering the city on the North (Kailasa range) and the South (Yarada range) (ii) The waltair high lands extending along the shore (iii) Extensive tidal swamp on the

West and Bay of Bengal on the Eastern side. Visakhapatnam is one of the highly industrialized centers in the state of Andhra Pradesh. Industrial development is at its peak in Visakhapatnam district and it is partly due to port based export and import activities. There are several major industries like Visakhapatnam Steel Plant (VSP), Hindustan Petroleum Corporation Ltd (HPCL), Coromandel Fertilizers Ltd (CFL), Bharat Heavy Plates and Vessel Ltd (BHPV) and a lot of other ancillary industries.

Human health may be affected directly by inspiration of gases or indirectly by ingestion of foods contaminated with air pollution. Air pollution is considered a direct contributor to fast aging, asthma, berylliosis, emphysema and mesothelioma, and as a contributing cause to bronchitis, cancer of the GI tract, and cancer of the respiratory tract. The association between air pollution especially particulate pollution and human health has been one of the important public health issues in the last few decades (Adrian et al., 2006; Lin et al., 2004).The researches using large-scale datasets have shown not only fairly consistent relationships between air pollutant levels and cardiovascular or respiratory diseases in a variety of communities in the industrialized world (Funk et al., 2005;Yang et al.,1998; Anderson et al.,2001;Wong et al., 1999) but also statistically significant associations between particulate matter concentrations and acute as well as chronic health outcomes all over the world (Pope et al.,1995;Dockery and Pope,1994).

The studies pertaining to the association of particulate pollutant concentrations with respect to health status of the residents are mandatory in urban areas of the developing countries like India by which one can frame strategies for protecting the health of the residential and floating population of the cities mainly by means of particulate pollution abatement. Lead is one of four metals that have most damaging effect on human health.

It can enter the human body through uptake of food (65%), water (20%) and air (15%). Food such as fruit, vegetables, meat, grains, sea food, soft drinks and wine may contain significant amount of lead. Cigarette smoke also contains small amount of lead. Lead can enter drinking water through corrosion of pipes. This is more likely to happen when the water is slightly acidic. That is why water treatment system is now required to carry out pH adjustment in water that will serve drinking purpose. The results of this study may form the basis for further in depth analysis of associated health factors, which is essential to the sustainable development of the city. According to doctors and environmental activists, the alarming increase in childhood asthma cases in the city is not just due to genetic predisposition but largely because of rising environment pollution.

Materials and Methods

The objectives of the present study are divided in to two major parts so as to generate a preliminary database on health status of the residents with respect to variation in the degree of particulate pollution in Visakhapatnam city. The first part is not only to acquire data on daily hospital admissions for respiratory diseases from major hospitals in Visakhapatnam city and but also to compare air quality along with the existing meteorological conditions during the year 2013.The second part is to study the blood

lead levels of the representative residents in some selected areas of Visakhapatnam so as to make preliminary estimation and correlation with environmental variables. The study areas selected for the first objective are within the urban limits of Visakhapatnam city, which includes King Gorge Hospital and Gajuwaka .The study population is the residents of these selected areas and specifically the residents that had admissions to hospital as in patients for respiratory diseases for the period of twelve months of the year 2013.

The first part of this preliminary investigation pertaining to health impacts of particulate pollution mainly involves the collection of health data pertaining to daily hospital admissions for some selected respiratory illnesses at major hospitals in the study area of Visakhapatnam city. In fact, the respiratory diseases have been classified as acute upper respiratory tract infections J00-J06), Influenza (J10-J11),Pneumonia (J12-J18),Rhinitis and Sinusitis(J30-J32),Bronchitis (J40-J42),Emphysema (J43),other chronic obstructive pulmonary disease (J44) and Asthma (J45-J46) on the basis of the International Classification of Disease, Tenth Revision (ICD10).

Data with special reference to asthma and bronchitis were collected from the hospitals along with the personal information like age,gender,marital status, ethnic group and district of residence. The collected database was classified on the basis of diseases and ages of the subjects and subsequently pooled together in a specific format for analyzing the database statically. It is to be noted that the statically analysis mainly includes the correlation and regression analyses, by which one can estimate the correlation coefficients and relative risks.

In the case of blood lead study, blood samples were collected by using heparin zed test tube from the residents of two selected areas who voluntarily donated the blood samples. The collected blood samples were analyzed to determine its lead level using Atomic Absorption Spectrometer by adopting the standardized method approved and recommended by the U S Environmental Protection Agency (USEPA). A questionnaire has been prepared for collecting the information from the donors of blood samples that includes the possible sources of lead exposure such as vehicular traffic, water lining, storage vessels, and house paint and nearby industries along with major occupational sources. It also has common schedule consisting of family identification particulars and health seeking behavior of the family. In this study a total of 450 subjects participated, which includes 200 men, 200 women and 50 children with an overall age range from 6 to 51 years.

Results and Discussion

Respiratory problems among children's, especially in the age group of 5 to 15 years, are escalating largely due to various forms of pollutions. The open dumping of coal and other bulk cargo by Visakhapatnam Port Trust that is creating major health problems. In some of the areas in Visakhapatnam the values of SPM and RPM are exceed 20 to 40 % more. Children's are suffering not only asthma, they are also suffering from various kinds of respiratory tract and lung infections as the pollutants and dust particles enter the body and mix with blood stream. Generally the asthma attacks during winter season due to dryness in the atmosphere and increased irritation to respiratory mucus.

Table.1 Number of hospital admissions for respiratory diseases (2012)

SL. No	Age group	Asthma	Bronchitis	Total
1	0 – 4	201	72	273
2	5 - 15	264	225	489
3	15 – 49	305	282	587
4	50 – 69	235	214	449
5	□ 70	195	123	318
	Total	1200 28.2%	916 21.53%	2116

Table.2 Weekly hospital admissions for respiratory diseases (2012)

SL. No	Age group	Asthma	Bronchitis	Total
1	0 – 4	201	72	273
2	5 - 15	264	225	489
3	15 – 49	305	282	587
4	50 – 69	235	214	449
5	□ 70	195	123	318
	Total	1200 28.2%	916 21.53%	2116

S. NO	Diseases	Number of hospital admissions per week			
		Min	Max	Mean	SD
1	Asthma	12	41	22.8	6.4
2	Bronchitis	11	32	19.5	5.2

Table.3 Weekly levels of Air pollutants and meteorological variables (2012)

S. No	Variable	Levels of air pollutants and meteorological variables			
		Max	Min	Mean	S.D
1	SPM (µg/m3)	166	54	96	22.4
2	RSPM (µg/m3)	83	21	_	_
3	Pb (µg/m3)	0.73	0.50	0.61	0.07
4	Temperature(°C)	42.7	11.7	31.9	0.98
5	Wind speed (m/s)	8.4	1.9	3.1	0.42
6	Humidity (%)	78	67	62.8	3.54

Table.4 Pearson coefficients of correlation between variables ($P < 0.05$)

Variable	SPM	RPM	Pb	Temp	WS	Hum	Asthma	Bronchitis
SPM	1.00	0.95	-0.57	0.53	-0.30	-0.25	0.18	0.32
RPM		1.00	-0.64	0.52	-0.35	-0.32	0.14	0.26
Pb			1.00	-0.32	0.35	0.32	0.14	0.29
Temp				1.00	0.01	-0.36	0.12	0.07
WS					1.00	0.00	-0.42	0.29
Hum						1.00	0.14	0.09
Asthma							1.00	0.04
Bronchitis								1.00

Table.5 Relative risk and 95% confidence interval of hospital admissions for respiratory diseases

S.No	Pollutants (µg/m3)	Relation risk		95% CI	
		Asthma	Bronchitis	Asthma	Bronchitis
1	SPM	1.02	1.07	0.82 – 1.14	0.95 – 1.12
2	RPM	1.04	0.99	0.92 – 1.09	0.95 – 1.03
3	Pb	0.98	1.02	0.77 – 1.04	0.96 – 1.07

Table.6 Descriptive statistics for blood lead levels (KGH)

Group	Number of samples	Blood lead concentrations (µg/dl)			
		Max	Min	Mean	SD
Male	100	57.6	19.5	31.2	7.6
Female	100	50.2	12.5	28.5	7.8
Children	25	14.2	2.0	5.1	2.9

Table.7 Descriptive statistics for blood lead levels (KGH)

Group	Number of samples	Blood lead concentrations (µg/dl)			
		Max	Min	Mean	SD
Male	100	56.3	19.5	31.2	7.8
Female	100	48.6	9.2	23.2	7.9
Children	25	13.2	1.8	5.1	3.2

Table.8 Blood lead concentration of Male residents in KGH

Age group	Blood lead concentrations (µg/dl)			
	Max	Min	Mean	SD
17 – 24	32.2	19.5	25.2	4.1
25 - 31	39.1	19.5	29.1	6.2
32 - 38	50.2	26.6	36.7	8.1
39 - 45	56.6	31.4	36.1	10.2
46 - 51	37.8	33.5	35.7	2.1

Table.9 Blood lead concentration of Male residents in Gajuwaka

Age group	Blood lead concentrations (µg/dl)			
	Max	Min	Mean	SD
17 – 24	36.5	19.5	26.1	5.2
25 - 31	50.6	20.5	31.1	7.1
32 - 38	50.5	22.6	36.7	10.5
39 - 45	33.5	25.4	29.4	3.8
46 - 51	51.2	35.5	38.8	8.4

Table.10 Blood lead concentration of Female residents in KGH

Age group	Blood lead concentrations (µg/dl)			
	Max	Min	Mean	SD
17 – 24	28.9	12.5	22.1	6.2
25 - 31	40.5	15.6	28.4	5.3
32 - 38	51.4	22.3	37.5	11.2
39 - 45	36.2	22.6	30.6	5.9
46 - 51	43.5	19.5	28.7	6.9

Table.11 Blood lead concentration of Female residents in Gajuwaka

Age group	Blood lead concentrations (µg/dl)			
	Max	Min	Mean	SD
17 – 24	27.4	9.2	19.7	6.5
25 - 31	48.2	12.5	24.2	8.0
32 - 38	3.2	16.4	27.62	11.8
39 - 45	46.4	14.8	24.1	7.1
46 - 51	35.9	11.5	27.2	5.1

Table.12 Blood lead concentration of Children residents in KGH

Age group	Blood lead concentrations (µg/dl)			
	Max	Min	Mean	SD
6	5.6	3.2	4.5	1.5
7	11.1	4.6	6.3	3.7
8	14.2	3.0	6.3	4.5
9	5.8	3.9	4.7	1.20
10	11.2	2.8	6.6	4.1

Table.13 Blood lead concentration of Children residents in Gajuwaka

Age group	Blood lead concentrations (µg/dl)			
	Max	Min	Mean	SD
6	5.6	3.2	4.5	1.5
7	11.1	4.6	6.3	3.7
8	14.2	3.0	6.3	4.5
9	5.8	3.9	4.7	1.20
10	11.2	2.8	6.6	4.1

Age group	Blood lead concentrations (µg/dl)			
	Max	Min	Mean	SD
6	5.6	3.2	4.5	1.5
7	11.1	4.6	6.3	3.7
8	14.2	3.0	6.3	4.5
9	5.8	3.9	4.7	1.20
10	11.2	2.8	6.6	4.1

The association between particulate air pollution and respiratory health effects has been well established, which is found in several review studies (Adrian G.Barnett et al., 2006). In this connection, a database is generated on hospital admissions due to asthma and bronchitis during the specific study period in Visakhapatnam city. In fact, it is estimated that there are 4,182 hospital admissions due to respiratory diseases during the study period and the generated database is presented in Table 1.

It is obvious from Table 1 that 28.2%of hospital admissions are due to asthma, where 21.53% of total hospital admissions are due to bronchitis. It is obvious from the Table 1 that the admission rate was highest in the 15-49 age groups and lowest in 0 -4 age group due to asthma and bronchitis.

Table 2 shows the descriptive statics of hospital admissions due to asthma and bronchitis during the study period in

Visakhapatnam city. While asthma affected residents have the maximum number of hospital admissions, the residents who are affected by the diseases of current concern have the same minimum number of hospital admissions. This database reveals the prevalence of the diseases of current concern in the study area.

Table 3 presents the descriptive statics of weekly levels on particulate pollutants and meteorological variables. While the pollutants such as SPM, RPM and Pb are within the permissible limits set by CPCB, the pollutant SPM crosses the standards rarely. The recorded temperature and relative humidity values are as those recorded in most of the cities in South India. It is to state the existing air quality and meteorological parameters have association with the diseases of the present investigation.

Table 4 explains that the results of calculated Pearson correlation coefficients among the variables of air quality, meteorology and hospital admission. It is found from the correlation coefficients that SPM has good correlation with RPM, Pb, temperature, wind speed and the RPM has very good correlation with SPM, Pb, temperature ,wind speed, humidity and bronchitis and Pb has good correlation with SPM, RPM, temperature, wind speed humidity and bronchitis. The particulates with special reference to RPM and Pb have good correlation with bronchitis. It is worth mentioning here that these particulates are fine particles and so they may enter the nasal system of our body and induce bronchitis and other respiratory diseases.

Relative risk is a measure of association between exposure to a particular factor and risk of a certain outcome. It is estimated by using single pollutant model analysis in the present investigation. In this single pollutant model, parameters of individual pollutants for SPM, RPM and Pb can be fitted into Position regression model. Subsequently, the relative risk can be calculated. The relative risks of hospital admissions for respiratory diseases (asthma, bronchitis) are calculated in the present investigation by increasing 10 µg/m3 of the pollutants concentration. In the case of asthma, the relative risk (RR) with respect to SPM is in the range of 0.82 to 1.14 with the mean of 1.02 for 95% confidence interval (CI). While the relative risk (RR) with respect to RPM is in the range of 0.92 to 1.09 with the mean of 1.04 for 95% confidence interval (CI), the relative risk (RR) with respect to lead is in the range of 0.77 to 1.04 with the mean of 0.98 for 95% confidence interval (CI). As far as bronchitis is concerned, the relative risk (RR) with respect to SPM is in the range 0.95 to 1.12 with the mean of 1.07 for 95% confidence interval (CI). As significant risk has been estimated from the results, it is worth mentioning that there are considerable effects of air pollution on the respiratory system of residents in the city.

In the blood lead study, a total of 450 subjects participated in this study, coming from the King Gorge hospital and Gajuwaka areas in Visakhapatnam city. Blood lead concentrations are measured spectrophotometrically in total 450 individuals that include 200 men (age range 17-51), 200 women (age range 17-51) and 50 children (age range 6-10). In males the lead concentrations in the blood samples vary from 19.5 to56.6 µg/dL. In women's it can be vary from 9.2 to 48.2 µg/dL, where as in children it can be seen from 2.8 to 14.2 µg/dL. Table 6 and 7

represents overall descriptive statistics of blood lead in the study areas. The blood lead concentrations in two places for various age groups of males, females and children are presented in Tables 8 to 13. The WHO permissible limit for lead in the blood for adult is 25µg/dl and for children it is 10µg/dl.

The maximum concentrations are recorded in the summer seasons and the minimum seasonal concentrations are recorded North East monsoon season. The seasonal variations can be correlated with meteorological conditions in the city. The health study reveals that the particular pollutants and respiratory diseases had good risk. From the correlation study the fine particle are the major reasons for the respiratory diseases. Lead is one of four metals. According to doctors and environmental activists, the alarming increase in childhood asthma cases in the city is not just due to genetic predisposition but largely because of rising environment pollution. It is observed that the mean lead concentration in males is higher than those in females and children. The value of calculated coefficient of variation is the lowest to males, while comparing with the related values to females and children. This states that the males have highest concentrations of lead in their bloods, which is confirmed by observing the database. It is observed that 78% of males, 47% of females and 10% of children have the blood lead concentrations that cross the permissible limits.

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