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STUDY OF MORBIDITY PATTERN OF A POPULATION EXPOSED TO INDUSTRIAL AIR POLLUTION AT TRIVANDRUM AND PUNE, INDIA

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Abstract- Industrial air pollution is of major concern to upcoming Indian cities like Trivandrum and Pune in terms of industrialization and urbanization. Even the urban population is exposed to ambient air pollutants; on the other hand the sub-rurals contribute to the cigarette smoke and kitchen cooking fuels. A quantitative analysis on the mean concentration of SO2, NOX, and SPM in four different industrial zones at Trivandrum and Pune was compared with that of non-exposed to control regions. These attributes were analyzed on the morbidity pattern of the exposed population for eleven various diseases and its hazardous effects are reported in the present study.
Key words - Industrial, pollution, ambient air, SPM, NOX, SO2

Introduction

According to annual pollution levels report, measured through 2010, published by the ministry of environment and forests, Delhi has regained its crown as India's most polluted city. In contrast, several big cities, including Mumbai and Bangalore, have seen peak air pollution levels go down substantially in 2010, compared to the previous two years. Also as per the report, air pollution levels increased in most of the major cities in north India, while going down in the south and west. In 2010, Delhi led the country in terms of particulate matter or dust pollution, registering a 7% increase in average concentration of very fine dust particles (less than 10 microns in size or PM10) to 259 microgram per cubic meter of air. Such minute particles accumulate in the lungs and are linked to asthma, lung cancer, cardiovascular issues, and premature death. According to the data, several cities in the country had PM10 levels higher than the recommended safe limit of 100 micrograms. The average PM10 levels dipped from 109 micrograms in 2009 to 94 in Mumbai and from 122 to 94 in Bangalore, bringing both the down to the safe level. Ludhiana, which had a PM10 level of 254 in 2009, saw it go down to 229 in 2010. Rising vehicular congestion is taking a toll on most Indian cities with a faster rate of increase in air pollution in smaller places like Pune, Nagpur and Amravati in the state becoming a cause for concern.

In India, urban population is exposed mainly to ambient air pollutants from automobile exhaust and industrial activities. Pollutants like SO_2, NOX, particulate matter and volatile organic compounds like Benzene, Formaldehyde, Butadiene etc. can affect human health. Though respiratory system usually bears the main brunt of air pollutants, many other disorders involving other organ systems even cancers are attributed to air pollution. Some of the pollutants are toxic to the hematopoietic system [1]. In addition to pollution, cigarette smoke contributes significant amounts of noxious substances rendering smokers more vulnerable in comparison to the non-smokers [2]. Apart from ambient air, urban people also suffer from the problems of water pollution and the adversities of their living environment. Lack of sanitation and personal hygiene play the role of additives and contribute to the sufferings of the city dwellers. Many studies have already shown the adverse effects of pollution that have affected the health of urban people [3-5]. In urban area also, some localities are principally industrial and some others are mainly commercial or residential. The problems also differ in relation to the variations of the localities. A comparative analysis of these areas in relation to the morbidities of the dwellers can be important in assessing the real scenario of urban environmental health. In India, this kind of studies being very rare, an effort has been made through this study to evaluate the health status of urban community of two Indian cities viz: Trivandrum and Pune respectively keeping in view the possible role of pollution on human health.

Study area and method

The exposed population was classified in to three zones in relation to the distance from the industrial outlet of Trivandrum and Pune; Zone-1 includes area within ½ Km from the factory, Zone-2 within ½ to 1 km and Zone-3 within 1 to 1½ km. A less polluted places located at a radius of 12 km away from there areas were taken as the Zone- 4. For the purpose of collection, computation and analysis of data, a new questionnaire based on the standard questionnaire (5) was developed and used. The study was conducted at Trivandrum in Kerala and at Pune in Maharashtra. The control group was non-exposed residents located at a radius of 20 km or more away from the industrial pockets.

For the definition of symptoms and subject categorization, following method was adopted [3]. Chronic cough was defined as cough that occurred on most days or four consecutive days or more aweek for three or more consecutive months. Chronic phlegm and coryza were defined similarly. Dyspnoea was defined as breathless on walking, requiring the subject to stop or slowdown for breath when walking on level ground. After selecting 1000 subjects from an index population based on the census data, a stratified random sampling technique 6 was adopted. Individuals permanently residing in the specified area and ready to cooperate with the study were selected in the year 2002. This was followed by conducting four main surveys with new questionnaires relating to the years 2004, 2006, 2008, 2010 with particular focus on the previously selected subjects. A regular follow-up exercise at an interval period of 4 months from 2002 to 2010 covering all seasons was resorted to. Separate case sheets were prepared for each individual to record the data relating to age, sex, income, smoking habits, type of housing, duration of residence, diseases etc. however factory workers were excluded from this purview on account of the constant risk of their exposure o individual emission and therefore felt to be unrepresentative of the general population residing in that area.

The ambient air quality of the industrial area and control area were studied. For this purpose, two stations in each area in the residential communities were located and NO2, SO2 & SPM in each area were measured for 24 hours/ day, twice a week for one year, using the standard methods approved by the Central Pollution Control Board [7, 8].

Results and Discussion

The mean concentration of SO2 in Zone-1 was 32.150 ± 5.499 micro gm/ m3, which was below the national ambient air quality of 60.00micro gm/m3 (annual average in residential areas). Zone-2, 3 and 4 also indicated SO2 concentration below the national air quality standard. The mean concentration of NOX in Zone-1, 2, 3 &4 was 25.383 ±1.94 micro gm/ m3, 21.583 ±2.574 micro gm/m3, 19.083 ±2.314 micro gm/m3 and 20.012 ± 1.24 micro gm/m3 respectively. It could thus be seen that the above values were well below the national ambient air quality standard of 60.00microgm/m3. Further the mean concentration of SPM of the exposed Zone-1, 2, 3 & 4 were 211.083 ± 26.986 micro gm /m3, 167.916 ±37.110 micro gm/m3, 140.121 ± 18.143 micro gm/ m3 and 142.00 ±1.29 micro gm/m3 respectively, whereas that of the non- exposed area (115.650 ±25.11 micro gm/ m3) was found to be above the national ambient air quality standard of 140.00 ±micro gm / m3.

The analysis of industrial pollution in the city of Pune was not different from that of the scenario at Trivandrum. The mean concentration of SO2 in Zone 1, 2, 3 & 4 was 30.726± 1.216, 35.620± 1.385, 34.121± 0.821 and 30.17±0.110 micro gm/ m3 respectively. The city of Pune recorded the NOX value corresponding to 22.512± 0.22, 20.22± 1.623, 18.023± 1.126 and 18.00±0.23 micro gm / m3 in Zone 1, 2, 3 & 4 respectively. The standard values of SPM in the respective Zones were 210.032± 06.216, 162± 10.101, 143.101±16.121 and 142.21±0.22 micro gm / m3 for all the four zones respectively (Table 2).

The meteorological data from IMD/VSSC reveals that the coastal area of Trivandrum is highly humid. Zone-1, Zone 2, Zone 3 and Zone 4 and Pune with industrial pollution exposed areas situated near the factory show a high prevalence of chronic respiratory symptoms as compared to the control area. The prevalence of dyspnoea was very high in Zone-1 (28.0%). It was 20.0% in Zone-2 and 18.1 % in Zone-3 whereas non exposed control area (Zone-4) showed only 9.2%. The prevalence of phlegm was 21.5%, 14.0%, 8.4% in Zone1, 2 & 3 respectively whereas the control area showed only1.9 %. The exposed area shows a high prevalence of chronic cough (Zone1-22.9 %, Zone2-9.6%, Zone3- 5.1%) compared to Zone 4 (8.1%). Prevalence of coryza was more in Zone 1 (9.3%) than the other zones. The non-exposed control population shows morbidity similar to standard low pollution area in several aspects.

Eventhough eleven disease symptoms directly related to morbidity was observed in the city of Pune, the rate of incidence of dysponea was 23.65% in Zone 2, showing maximum infections. This was followed by Hypertension, chronic cough, Coryza and Phlegm ranging between 18 – 9 % of incidents in the population irrespective of the Zones (Table4). Skin rashes, Thyroid problems, Cardiac problem, Diabetes and Epilepsy also contributed to 1-10 % of the population studied at Pune, further attributing the pure health status of humans and susceptibility to other vulnerable diseases and environmental issues.

The potential health hazards associated with the inhalation of air borne pollutants are now well known. The best way to study the effects of pollution affecting the health of human beings is to conduct a comprehensive health survey to underline the causes that account for higher morbidity and mortality among the exposed population in juxtaposition with that of the non-exposed control population. The International studies [6,7] have shown that there is close nexus between air pollution and decrements in lung infection. Air pollutants like SO2, oxides of nitrogen, the suspended particle matter (PM10) etc. have found to be causing increased respiratory morbidity like chronic dyspnoea, frequent

colds, post nasal discharge and to a great extend, malfunction of the lungs(8). An interacting factor in all these studies however was tobacco smoking. Evidences go to show that tropical weather with high humidity has a bearing on ozone and SO2 to concentrate mainly on the upper airways of the respiratory system [9].

This prospective environmental health study reveals the impact of air pollution on a population inhabiting contiguous to an industrial area. The data collected from industrial pollution exposed area was subsequently compared to that collected from a non- exposed area. The objective of this study was to determine the pattern of morbidity among the city dwellers as well as to do a comparative analysis of different areas within a city.

Apart from being the capital of India's most literate and socially developed state, Trivandrum is a strategically important city in Southern India. Most of the industrial and commercial establishments in Kerala are concentrated in the coastal zone. There are about 300 large and medium scale industries and 1,66,000 small scale industries, most of them are located in the coastal area. Of these 250 large and medium scale industries and 5000 small scale industries are polluting significantly to the environment. Pune has a booming economy. There are two industrial estates in the outskirts of Pune developed by the Maharashtra Industrial Development Corporation (MIDC). This is besides the already bustling industrial hub of Pimpri-Chinchwad. A large number of Indian industry majors and MNC's have set up base in Pune and its suburbs. Pune has also emerged as a software industry hub. Many of the leading Indian software companies have their presence in Pune. The BPO industry is also booming with many leading Indian names and MNC's registering their presence in Pune. The urbanization has posed heavy increase in the number of vehicles on the road and on the contrary rural group of supporting and depending personnel migrate and over populated on the adjoining areas of these industrial hubs. These specific groups truly depend on kitchen fuel for their domestic purpose. But still, poor housing, non existent sanitation, unprotected water supply, poor medical care, use of wood as kitchen fuel were all exerting significant contributions in the general health of both the exposed and non exposed population. Follow up study revealed that serious situations prevailed in the exposed community. International studies unequivocally have confirmed the link between high levels of particulate air pollution and the decline in lung function and premature death due to cardiovascular diseases. Particulates are now treated as toxic air contaminants and prolonged exposure to them may cause dyspnoea and higher mortality rate due to dyspnoea as compared to control population. Over population, environmental issues, pollutions and urbanization have added a real burden on the health aspects of human to utmost concern and only rescue is to educate, analyze and take strict actions against such dangerous practices.

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Table 1- Quantitative analysis of SO2, NOX and SPM at Trivandrum zones

Parameter	Zone 1(micro gm/m3)	Zone2 (micro gm/m3)	Zone 3 (micro gm/m3)	Zone 4 (micro gm/m3)
SO2	32.150±5.499	31.56± 2.691	30.42± 0.980	28.12±0.241
NOX	25.383± 1.94	21.583±2.574	19.083± 2.314	20.012±1.24
SPM	211.083± 26.986	167.916±37.110	140.121± 18.143	142.00±1.29

Table 2- Quantitative analysis of SO2, NOX and SPM at Pune zones

Parameter	Zone 1 (micro gm/m3)	Zone2 (micro gm/m3)	Zone 3 (micro gm/m3)	Zone 4 (micro gm/m3)
SO2	30.726± 1.216	35.620± 1.385	34.121± 0.821	30.17±0.110
NOX	22.512± 0.22	20.22± 1.623	18.023± 1.126	18.00±0.23
SPM	210.032± 06.216	162± 10.101	143.101±16.121	142.21±0.22

Table 3- Morbidity studies for disease correlation at Trivandrum

Symptoms	**n=375 Zone 1**		**n=392 Zone 2**		**n=365 Zone 3**		**n= 1000 Zone 4**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Dysponea	92	24.53	97	24.74	60	16.43	42	4.2
Chronic cough	79	21.6	42	10.71	24	6.57	38	3.8
Phlegm	69	18.4	34	8.67	40	10.95	39	3.9
Coryza	35	9.33	42	10.71	39	10.68	36	3.6
Itching+Rashes +Skin problems	19	5.06	14	3.73	14	3.83	12	1.2
Thyroid	7	1.8	6	1.53	9	2.46	10	1.0
Cardiac	7	1.8	5	1.27	3	0.82	12	1.2
Diabetes	24	6.4	14	3.57	20	5.47	14	1.4
Epilepsy	4	1.06	12	3.06	9	2.46	10	1.0
Hypertension	79	21.06	80	20.4	68	18.63	43	4.3
Chronic headache	59	15.73	39	9.94	42	11.50	29	2.9

Table 4- Morbidity studies for disease correlation at Pune

Symptoms	**n=519 Zone 1**		**n=630 Zone 2**		**n=547 Zone 3**		**n= 596 Zone 4**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Dysponea	102	19.65	149	23.65	120	21.93	104	17.44
Chronic cough	69	13.2	84	13.33	62	11.33	72	12.08
Phlegm	63	12.13	59	9.36	64	11.70	52	8.72
Coryza	39	7.51	64	10.15	66	12.06	76	12.75
Itching+Rashes +Skin problems	29	5.58	24	3.80	20	3.05	29	4.86
Thyroid	10	1.92	12	1.90	19	3.47	40	6.71
Cardiac	10	1.92	10	1.58	9	1.64	34	5.70
Diabetes	34	6.55	23	3.65	42	7.67	26	4.36
Epilepsy	14	2.69	18	2.85	12	2.19	30	5.03
Hypertension	89	17.14	110	17.46	79	14.44	94	15.77
Chronic headache	60	11.56	77	12.22	54	9.87	39	6.54