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A comparative study of vital capacity of adult males in two different air pollutant zones of Kolkata, West Bengal, India

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ABSTRACT

There is growing concern about health effects of air pollution in Kolkata. Purpose of present study was analyzing relationship between levels of air pollutants and vital capacity of adult male living in two different air pollutant zones of Kolkata, West Bengal. Air pollution data of two ambient air quality monitoring stations located at Rabindrabharati and Victoria Memorial was collected from West Bengal Pollution Control Board, Kolkata for period from January 2012 to March 2012. Study was conducted on two hundred males of age range 17-22 years, subdivided into two groups from living within 3km radius of that two monitoring stations. Vital capacity was measured in standing position with simple spirometer. Results were expressed as mean ± SD. Independent samples T test was conducted to compare between two groups. Results revealed that PM10, SO_2 concentrations were significantly higher in Rabindrabharati, whereas no significant differences were noted in NO_2 and CO concentrations though values were higher at Rabindrabharati than Victoria Memorial. Vital capacity was significantly lower in males of Rabindrabharati. Association between higher pollutant concentrations and reduced vital capacity suggested that there may be effect of air pollution on vital capacity as well as lung function in studied population.

KEYWORDS

Air pollution;
Vital capacity;
Male;
Kolkata.

INTRODUCTION

Air pollution has become such an invasive problem across the country that there are practically no spaces left unaffected. About half of the World's population now lives in urban areas because of the prospect for a better quality of life. These dense populations are causing excess stress on the natural environment, with of effects at urban, regional and global levels. In today's world, air pollution has become one of the troubles to people of the megacities. Harmful consequences on the body from pollutants are multifactorial, with acute or chronic exposures including causes of cardiovascular disease and impairing pulmonary function[1]. Street traffic generate suspended particulate matter (SPM), oxides of sulphur (SOx), oxides of nitrogen (NOx), and car-

bon monoxide (CO), which makes unfavorable health effects on the exposed population. Several studies highlighted the important role of ambient air pollution to excess morbidity and mortality[2,3]. Schwela[4] found a significant positive correlation between environmental pollution, decreased pulmonary functions and respiratory morbidity. According to Peters *et al.*[5] particulate air pollution has been concerned in contributing to the incidence and severity of respiratory disease. Particulate air pollution has been correlated with increase in hospital admissions for cardiovascular and respiratory disease and mortality in many countries[6,7] including India[8,9]. Pulmonary function testing measures the function of lung capacity and lung and chest wall mechanics to determine whether or not the patient has a lung problem. Vital capacity is an important index in pulmonary function[10].

Kolkata is one of the most polluted metropolitan cities in India. Vehicular pollution is no longer just an insubstantial threat in Kolkata - as the air grows perceptibly darker. Many studies on Vital capacity in the general population have been carried out previously in India and abroad[11-16]. A study by Chattopadhyay *et al*[17] revealed that a number of school students in Kolkata city are having different types of respiratory symptoms. In the majority of the studies, researchers deal with community level or broader air pollution. But research is needed to investigate the effects of air pollution in non-occupationally exposed subjects residing in different areas of Kolkata. In the present study an attempt had been made to evaluate the effect of air pollution on vital capacity of adult male residing in two different zones of Kolkata exposed to two different level of air pollution.

EXPERIMENTAL

Selection of place

Study areas were chosen from Kolkata, West Bengal. The air pollution data of the period from January 2012 to March 2012 was collected from West Bengal Pollution Control Board (WBPCB), Kolkata (*www.wbpcb.gov.in)* which included the pollutant levels at the two ambient air quality monitoring stations located at Rabindrabharati (North Kolkata) and Victoria Memorial (Central Kolkata). The major air pollutants monitored at these stations were particulate matter (PM10), sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and carbon monoxide (CO).

Subjects

Study was conducted on two hundred males of the age range 17-22 years, subdivided into two groups - living within 3 km radius of that two monitoring stations. All the participants (subjects) were resident in those two zones for a minimum period of three years. Subjects with acute or chronic respiratory illness, past or present history of smoking, systemic illness and on chronic medication were excluded from the study. All institutional policies concerning the human subjects in research were followed. Ethical approval was taken from the competent authority.

Data collection

The data collected included anthropometric parameters and measurement of vital capacity.

Anthropometric parameters

Standing height in cm was measured with shoes removed, feet together. Weight in kg was measured with shoes and Jackets removed.

Body surface area (BSA) and Body mass Index (BMI) were calculated by Du-Bois and Du-Bois Formula[18] and Meltzer's equation[19] respectively.

Determination of vital capacity

Vital capacity was measured in the standing position with simple spirometer. The subject was asked to stand comfortably, facing the spirometer so that the subject can see the movement of the bell. The subject is asked to inspire as deeply and as fully as possible to fill the lungs. Then while keeping the nostrils closed with a nose clip and the mouthpiece held firmly between the lips, the subject is asked to expel all the air that he can with maximum effort into the spirometer. The forced expiration should be deep and quick but without haste. Three satisfactory readings were taken at intervals of five minutes and the highest among the three was accepted[20].

Statistical analysis

All the values are expressed as Mean ± Standard Deviations (SD). Statistical package for the social sci-

ence (SPSS) version 20 was used for analysis. Independent samples T test were adopted for statistical analysis of the data.

RESULTS

The ambient air quality data (Mean ± SD) as reported by WBPCB in the two areas of Kolkata are shown in TABLE 1. Values of PM10 of both regions were much more than the national ambient air quality standards, while SO_2 and CO were within the standards. On the other hand, NO_2 of Rabindrabharati showed higher values than standard but was lower in other zone. Comparison of the two ambient air quality data revealed that PM10 and SO_2 were significantly higher ($p<0.01$) in Rabindrabharati than Victoria Memorial zone whereas no significant difference was obtained in NO_2 and CO, although values were higher in Rabindrabharati area.

TABLE 1 : Level of significance of difference in air pollutant concentration between two zones of Kolkata

Air Pollutant	National Ambient Air Quality Standard	Rabindrabharati	Victoria Memorial	'T' – test
PM10 (μg/m3)	100	184.03 ± 53.76	125.27 ± 63.59	p<0.01
SO2 (μg/m3)	80	28.34 ± 16.27	7.15 ± 4.20	p<0.01
NO2 (μg/m3)	80	81.60 ± 49.16	75.02 ± 43.15	NS
CO (mg/m3)	04	1.59 ± 1.76	1.4414 ± 0.78	NS

The anthropometric parameters and vital capacity of the adult males residing in the two zones of Kolkata are shown in TABLE 2. No statistical difference was observed between the groups on these anthropometric parameters. But vital capacity was significantly higher ($p<0.01$) in males of Victoria Memorial zone when compared to Rabindrabharati zone.

TABLE 2 : Level of significance of difference in anthropometric parameters and vital capacity of adult male

Parameters	Adult male		't'–test
	Rabindrabharati (n =100)	Victoria Memorial (n=100)	
Height (cm)	165.56 ± 5.80	164.61 ± 5.61	NS
Weight (kg)	56.34 ± 4.61	56.03 ± 4.39	NS
BSA (m2)	1.62 ± 0.06	1.61 ± 0.08	NS
BMI (kg/m2)	20.66 ± 2.44	20.68 ± 1.40	NS
Vital Capacity (l)	3.58 ± 0.38	4.08 ± 0.37	p<0.01

NS= Not Significant

DISCUSSION

Literature suggests the adverse effects of long-term exposure to ambient air pollution on lung function[21]. The effects of outdoor air pollution both from acute and long term exposure make the risk of respiratory symptoms, declined lung function, add to daily admission to hospital with cardiorespiratory diseases, as well as increasing mortality[22,23]. Gauderman *et al*[24] showed the effect of air pollution on lung development from 10 to 18 years of age. A study by Scarlett *et al*[25] revealed statistically significant adverse effect of airborne respirable particulate matter, measured as PM10, on lung function in children in south-east England. A relationship between SO_2 exposure and daily mortality, morbidity and a reduction of FEV1 has been reported in urban areas[26]. Long term NO exposure also adds to respiratory symptoms and reduced lung function parameters. Chang *et al*[27] concluded that the short-term exposure to O_3 and PM10 was associated with reducing FVC & FEV1 and CO & SO_2 exposure had a strong 1-d lag effect on FVC and FEV1 of adolescent school students in a mass screening program in Taipei city, Taiwan. According to the study by Peters *et al.*[28] PM10, PM2.5, and NO_2 were each significantly correlated with lower FVC, FEV1 and maximal midexpiratory flow (MMEF) in Southern California public school children. Air pollution exposure mainly occurs by inhalational route, and hence airway epithelium is first to be affected. The airway epithelium in response, releases reactive mediators, which play an important role in the inflammatory response[26].

The present study also showed the fact of unfavorable effect on lung function on adult male. Air pollutant concentration was higher in Rabindrabharati zone than Victoria Memorial zone of Kolkata. Some of the pollutants showed significantly higher values in Rabindrabharati zone. Participants of the two regions were from same socio-economic and nutritional status. One group came from Rabindrabharati zone where the

air pollutant level was high and the other group was from Victoria Memorial zone where the pollutant level was low. Results demonstrated that there were no significant differences in their age, height, weight, BSA and BMI also. However, vital capacity was lower in the males from Rabindrabharati zone. Hence, it comes into views that it was only environmental factors which might be the major determining factor for the difference in vital capacity. Automobile exhaust is a major cause of pollution in urban areas. A relationship between the occurrence of certain symptoms and household location with respect to distances from roadside has been reported by Nakai *et al.*[29]. Study by Gao *et al.*[30] reported that long-term exposure to higher ambient air pollution levels was associated with lower lung function in Chinese schoolchildren, especially among boys. Chattopadhyay *et al.*[17] found that a number of school students of Kolkata city are having different types of respiratory symptoms and concluded that long-term effect of exposure into such environment may develop lung functional impairments.

Several studies have shown the association of atmospheric pollutants to many types of health problems of many body systems including the respiratory, cardiovascular, immunological, haematological, neurological and reproductive developmental systems. Some studies have reported the increases in respiratory and cardiovascular problems at outdoor pollutant levels well below standards set by such agencies as the US EPA (United States Environmental Protection Agency) and WHO[31]. Adverse effects on respiratory health are not bounded to high concentrations of air pollutants, but have also been observed at relatively low concentrations[32]. Deleterious health effects may result from exposure to pollutants at concentrations that are lower than recommended standards. Indeed, research to date has failed to establish a "threshold" limit for which there is no adverse health effect[33]. A cross-sectional study of respiratory symptoms and repeated pulmonary function testing in three zones from two geographically different areas in Tokyo, revealed that exposure to automobile exhaust may be correlated with respiratory symptoms[29]. Another study by Roy *et al.*, 2012[34] revealed that exposure to ambient particulate matter was associated with decreased growth in lung function among Chinese children. So, in our study the lower vital capacity of sedentary adult male of Rabindrabharati zone might be due the impact of higher air pollutants which warrants further investigation.

CONCLUSIONS

The present finding provide supports that exposure to high air pollutant concentration might be cause of decreased vital capacity of adult male comparing to those who were exposed to less air pollution which needs further investigation.

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