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Research Paper

Assessment of vital capacity of adult females residing at two different air pollutant zones of Kolkata, West Bengal, India

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ABSTRACT

In Kolkata, air pollution has been a matter of concern regarding health effect. The purpose of the present study was to examine the association between the levels of air pollutants and vital capacity as well as respiratory function of adult female residing at two different air pollutant zones of Kolkata, West Bengal. Ambient air quality monitoring data of the two stations located at Rabindrabharati (Station 1) and Victoria Memorial (Station 2) was collected from West Bengal Pollution Control Board, Kolkata for the period from January, 2012 to March, 2012. Two hundred females of the age range 17 to 22 years were volunteered for the study. They were subdivided into two groups from living within 3 km radius of that two monitoring stations. Vital capacity was measured in the standing position with simple spirometer. Results expressed as mean ± SD were analyzed by independent samples T-test for comparison between the two groups. From the study, it was revealed that PM10 and SO_2 concentrations were significantly higher in station 1, whereas no significant differences were noted in NO_2 and CO concentrations, though, values were higher at station 1 than 2. Vital capacity was significantly lower in females of station 1. The relationship between higher pollutant concentrations and reduced vital capacity revealed that there may be an effect of air pollution on vital capacity as well as, lung function in the studied population.

Key words: Air pollution, vital capacity, lung function, female.

INTRODUCTION

Air pollution has become such a pervasive problem across the country that there are virtually no places left unaffected. For getting opportunity for a better quality of life, about half of the World's population now lives in urban areas and the growth of urban environments presents a major challenge.

Along with modernization, air pollution has become one of the most imperative problems of the megacities. Road traffic produces Suspended Particulate Matter (SPM), oxides of sulphur (SOx), oxides of nitrogen (NOx), and carbon monoxide (CO), which makes adverse health effects on the exposed population.

A number of studies emphasized the important contribution of ambient air pollution to excess morbidity and mortality (Schwartz, 2001; Le et al., 2010) and causes of cardiovascular disease and impairing pulmonary function (Sharman, 2005).

Particulate air pollution contributes to incidence and severity of respiratory disease (Peters et al., 1997). Particulate air pollution exposure has been found to have association with increased hospital admissions for cardiovascular and respiratory disease and mortality in many countries (Samet et al., 2000; Dockery, 2009) including India (Kumar et al., 2010; Rajarathnam et al., 2011).

Vital capacity is an important index in pulmonary function (Chatterjee et al., 2011). 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.

Kolkata is one of the most polluted metropolitan cities in India where vehicular pollution is no longer just an intangible threat. Vital capacity in the general population have been studied previously in India and abroad (Singh et al.,1993; González-Camarena et al., 1993; Chatterjee et al., 2010a, 2010b, 2011a). But generally, researchers dealt with community level or broader air pollution.

More research is required to examine the effects of air pollution in non-occupationally exposed subjects especially females residing in different areas of Kolkata. Consequently, an effort had been made in the present study to estimate the differential effect of air pollution on vital capacity of adult females residing at the two different zones of Kolkata exposed to two different levels of air pollution.

MATERIALS AND METHODS

Selection of place

Two zones of Kolkata, West Bengal were chosen for the study. Air pollution data at the two ambient air quality monitoring stations located at Rabindrabharati in North Kolkata (Station 1) and Victoria Memorial in Central Kolkata (Station 2) was collected for the period from January, 2012 to March, 2012 from West Bengal Pollution Control Board (WBPCB), Kolkata (www.wbpcb.gov.in). 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

According to Krejcie and Morgan (1970), the sample size was estimated. Study was carried out on two hundred females of the age range 17 to 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 eliminated for the study. All institutional policies concerning the human subjects in research were followed. Ethical approval was taken from the competent authority.

Data collection

Anthropometric parameters and vital capacity were measured.

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 (Du-Bois and Du-Bois, 1916) and Meltzer's equation (Meltzer et al., 1988) respectively.

Determination of vital capacity

Vital capacity was measured in the standing position with simple spirometer. The technician was blinded regarding the matter that from which zones subject came. The subject was requested to stand comfortably, facing the spirometer so that the subject can see the movement of the bell. The subject was 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 was asked to expel all the air that she 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 (Chattopadhyay, 2011).

Statistical analysis

All the values are expressed as mean ± standard deviations (SD). Statistical package for the social science (SPSS) version 20 was used for analysis. Statistical analysis of the data was done by independent samples T-test.

RESULTS AND DISCUSSION

Table 1 showed the ambient air quality data (Mean ± SD) as reported by WBPCB in the two areas of Kolkata. 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 station 1 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 station 1 than 2, whereas, no significant difference was obtained regarding NO_2 and CO, although, these values were higher in station 1.

Table 2 showed mean ± SD of anthropometric parameters and vital capacity of the adult females residing in the two zones of Kolkata. There were no significant differences between the groups on these anthropometric parameters. But vital capacity showed significantly higher value ($p<0.01$) in females of station 2 zone when compared with station 1.

The consequences of outdoor air pollution both from acute and long term exposure, contribute to risk of respiratory symptoms, decreased lung function, increased

Table 1. Level of significance of difference in air pollutant concentration between two zones of Kolkata.

Air pollutant	National ambient air quality standard (h)	Kolkata zones		T - test
		Station 1	Station 2	
PM10 (µg/m^3)	100 (24)	184.03±53.76	125.27±63.59	p<0.01
SO_2 (µg/m^3)	80 (24)	28.34±16.27	7.15±4.20	p<0.01
NO_2 (µg/m^3)	80 (24)	81.60±49.16	75.02±43.15	NS
CO (mg/m^3)	04(1)	0.07±0.07	0.06±0.03	NS

Table 2. Level of significance of difference in anthropometric parameters and vital capacity of adult female.

Parameters	Adult female		T - test
	Station 1 (n =100)	Station 2 (n=100)	
Height (cm)	157.06± 5.80	155.74±4.81	NS
Weight (kg)	53.10 ± 7.31	53.34 ± 4.61	NS
BSA (m^2)	1.52±0.11	1.51±0.08	NS
BMI (kg/m^2)	21.54±2.85	21.98±1.50	NS
Vital capacity (ml)	2620.67±451.36	2796.67±404.15	p<0.01

p- value= 0.004; NS= Not significant.

daily admission to hospital with cardio-respiratory diseases, as well as, increasing mortality (Ackermann-Liebrich et al., 1997; Jalaludin et al., 2004).

Air pollution in urban areas reported a relationship between SO_2 exposure and daily mortality, morbidity and a reduction of FEV1 (Goyal and Khaliq, 2011). Long term NO exposure also causes increase in respiratory symptoms and decreased lung function parameters. A study by Peters et al. (1999) revealed that PM10, PM2.5, and NO_2 were each significantly associated with lower FVC, FEV1, and maximal mid-expiratory flow (MMEF) in Southern California public school children.

Chang et al. (2012) concluded that the short-term exposure to O_3 and PM10 was associated with reducing FVC and FEV1 and CO andSO_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.

Exposure to air pollution 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 (Goyal and Khaliq, 2011).

The present study also supported the fact of adverse effect on lung function on adult female. It was revealed that air pollutant concentration was higher in station 1 than 2 of Kolkata. Some of the pollutants showed significantly higher values in station 1.

In this study, in spite of belonging to same socio-economic and nutritional status, one group of subjects came from station 1 where the air pollutant level was high and the other group was from station 2 where the pollutant level was low.

Results showed that there were no significant differences in their age, height, weight, BSA and BMI also. However, vital capacity was lower in the females from station 1. Hence, it appears that it was only environmental factors which might be the major determining factor for the difference in vital capacity. It was clear from Figure 1 that our present data of vital capacity of station 1 was closer to another study on vital capacity of Indian female by Chatterjee et al. (2010) but much lower than station 2.

Automobile exhaust is a major cause of pollution in urban areas. Nakai et al. (1999) reported a relationship between the prevalence of certain symptoms and household location with respect to distances from roadside. Chattopadhyay et al. (2005) reported 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. Research showed (Butter, 2006) that females are more vulnerable to environmental pollution.

Numerous 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 (Katsouyanni, 2003; WHO, 2005; Sunyer, 2008; Poursafa et al., 2011).

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 (Curtis et al., 2006). Adverse effects on respiratory health are not limited to high concentrations of air pollutants, but

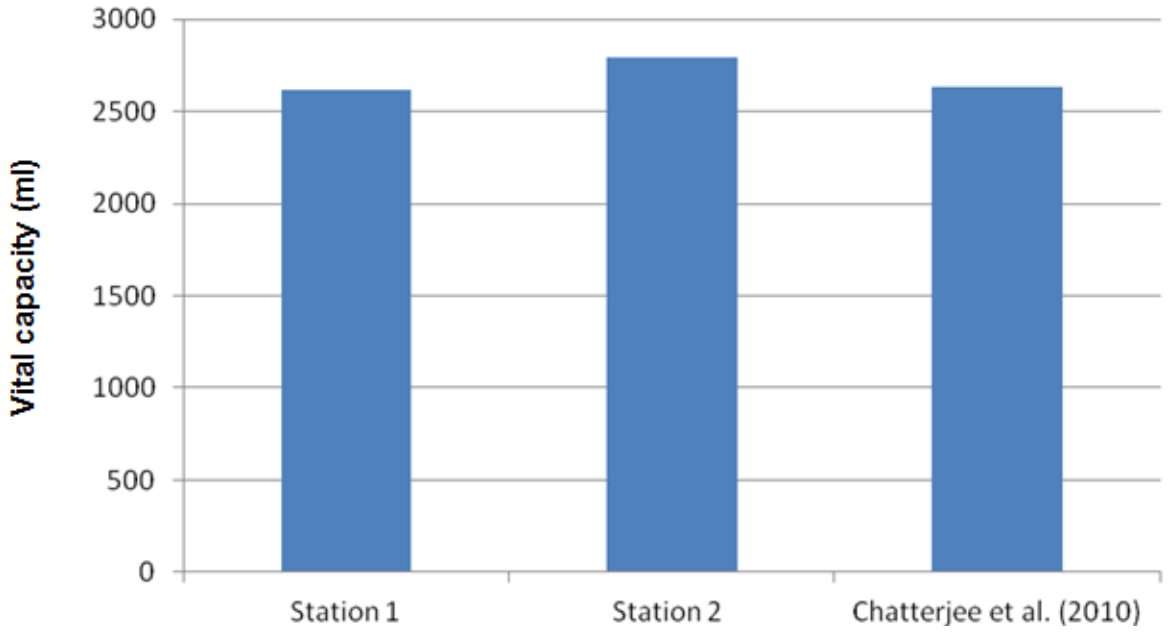

Figure 1. Difference in vital capacity of adult females between two zones and comparison with previous data.

have also been observed at relatively low concentrations (Schikowski et al., 2010).

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 (Kunzli, 2002). 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 associated with respiratory symptoms (Nakai et al., 1999).

Another study by Sekine et al. (2004) revealed the long term effects of exposure to automobile exhaust on the pulmonary function of female adults in Tokyo, Japan. So, in our study the lower vital capacity of sedentary adult female of station 1 might be due to the impact of higher air pollutants which warrants further investigation.

Conclusions

The present finding offer supports that high air pollutant exposure might be the cause of declined vital capacity of adult female as compared to those who were exposed to less air pollution which needs further investigation.

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