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Changes in Lung Function status of Adult Female over last one decade: A Cross-Sectional study in Kolkata, India

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Abstract

Keeping in view the present air condition of Kolkata, study was planned to distinguish lung function status of female citizens in a period gap of one decade. Healthy, non-smoking female aged 20-34 years, residing in Kolkata were undergone for Lung function tests. According to age subjects were divided into three groups (20-24, 25-29, 30-34 yr). Anthropometric and lung function parameters (FVC, FEV_1, MVV) were recorded in the year 2003 and 2013. They were examined for spirometric lung functions by method and technique recommended by American Thoracic Society. Student's 't' test was executed to compare between the age matched groups of 2003 and 2013. No significant difference was observed in height, weight, BMI between the age matched groups of 2003 and 2013. All lung function parameters were found to be reduced in age matched groups of 2013 as compared to 2003. FVC, FEV_1 were significantly ($p<0.01$) lower in 25-29 yrs and 30-34 yrs age group of 2013. There was also significant decrease in MVV for all age matched population of 2013 compared to that of 2003. Inactive lifestyle and air pollution probably have caused decline in lung function in the female population of this city.

Keywords: Air pollution, FVC, FEV_1, Kolkata, MVV.

Introduction

Lung function tests have been increasingly applied for evaluation and clinical management of respiratory disarray and have developed into an integral part of assessment of pulmonary disease. Pulmonary function values are influenced by race, age, sex, height, weight[1,2], physical activity patterns[3,4] as well as environmental, genetic[5], socio-economic, nutritional status[6,7], geographic condition and ethnic and racial origin[8] and technical parameters[5].

The health consequences of breathing polluted air are well documented, ranging from increased cardiorespiratory morbidity and mortality to increased occurrence of respiratory symptoms and decrements in lung function[9,10]. Over the last two decades, epidemiological studies have established a significant positive correlation between environmental pollution, declined pulmonary functions and respiratory morbidity[11].

Air pollution in most of the urban centres in developing countries has reached the alarming levels. There is no exception in India. Metro cities and major towns of India are troubled with emission from old industries and exponentially growing number of automobiles. Air quality on the city of Kolkata (a metro city of India) appears to be worsening. Pollution level in the city and its outskirts is alarming[12].

Though industries, thermal plants and domestic activity also add to air pollution in Kolkata, but the largest emitter of air pollutants is transport sector (Department of Environment, Government of West Bengal and West Bengal Pollution Control Board, 2002). Moreover, Kolkata experienced a remarkable growth in motor vehicle. According to global pollution and health, a report published in 1996 by WHO (World Health Organization) and UNEP (United Nations Environment Program), Kolkata has been placed among the 41 most polluted cities of the world with respect to SPM level. The average SPM level has increased from 237 $\mu g/m^3$ in 1990 to 354.3 $\mu g/m^3$ in 1995.

Department of Environment, Government of West Bengal and West Bengal Pollution Control Board (2002) reported citizens of Kolkata showed higher incidence of respiratory symptom complex (RSC) than rural subjects. Their results illustrated that 45% of rural individuals (90 out of 200) had some form of RSC. On the contrary, three fourth of urban individuals (970 out of 1310) showed the signs of RSC. Therefore, people living in Kolkata experienced 65% more respiratory problems than their rural counterparts and that rural areas, namely Burdwan, Midnapore, Birbhum and 24 Parganas (south) district of West Bengal where pollution level was expected to be much less due to negligible numbers of automobiles and absence of factories.

It is supposed that lifestyle and socio-economic conditions have been changed markedly in various cities of India, Kolkata being no exception. Moreover, hardly any community based research has been conducted to investigate the changes of lung function. Still, there is little data on the effects of air pollution on lung function in adults specially on female. But research showed[13]

that females are more vulnerable to environmental pollution. Whether these changes are revealed in lung function of individuals was the subject of this cross sectional population study carried out at an interval of 10 years in the similar population of Kolkata city. The primary aim of this study was to compare the lung function parameters in the year 2003 and 2013 from a selected healthy, asymptomatic, nonsmoker female population between age group of 20-34 yrs belonging to Kolkata.

Material and Methods

Subjects: Study was carried out on six hundred females of the age range 20-34 years subdivided into two groups according to the study conducted in the month of January to April, 2003 and 2013 i.e. one group was studied in 2003 and another in 2013. The volunteers were divided into three groups according to their age (20-24 yr, 25-29 yr, 30-34 yr). All the participants (subjects) were resident of Kolkata for a minimum period of fifteen years. Smokers, asthmatics, obese individuals and persons with history of any recent illness or having history of any cardiopulmonary disease were excluded from this study. The selected subjects were of sedentary workers belonging to middle socioeconomic class as per the categorization set up by the West Bengal Housing Board[14]. People with regular physical activity or industrial workers were not included in this study. All institutional policies concerning the human subjects in research were followed. Ethical approval was taken from the competent authority. A detailed clinical history was obtained and clinical examination was performed before the volunteers were selected for the pulmonary function tests.

Data Collection: The data collected included anthropometric parameters and measurement of Lung function.

Anthropometric parameters: Standing height in cm was measured with shoes removed, feet together. Weight in kg was measured with shoes and Jackets removed. Body mass Index (BMI) was calculated by Meltzer's equation[15].

Determination of Lung function tests: During the testing, the subjects were observed for coughing or wheezing. All tests were done in the standing position and a noseclip was used. The recording was carried out every day between 11:00 AM to 4:00 PM to reduce the factor of diurnal variation. The spirometry was performed with a modified water-sealed Toshiwal Expirograph (9l capacity) with sodalime cannister removed. The spirometer met the technical specifications of the American Thoracic Societ[16]. The spirometric measures consisted of forced vital capacity (FVC), FEV_1, maximum voluntary ventilation (MVV). The terminology of the ventilatory function tests is in accordance with the recommendations of the American Thoracic Society[16]. From each subject at least three satisfactory spirograms were obtained. Performance of spirometry and selection of the best spirogram were made according to the method outlined by American Thoracic Society[16]. Measurement and calculations of spirometric results were made according to the techniques recommended by Kory *et al.*[17] and Intermountain Thoracic Society[18]. The volumes and flow rates were corrected to body temperature and pressure, saturated with water vapour (BTPS). The spirometer was calibrated every week by using Palmer respiratory hand pump.

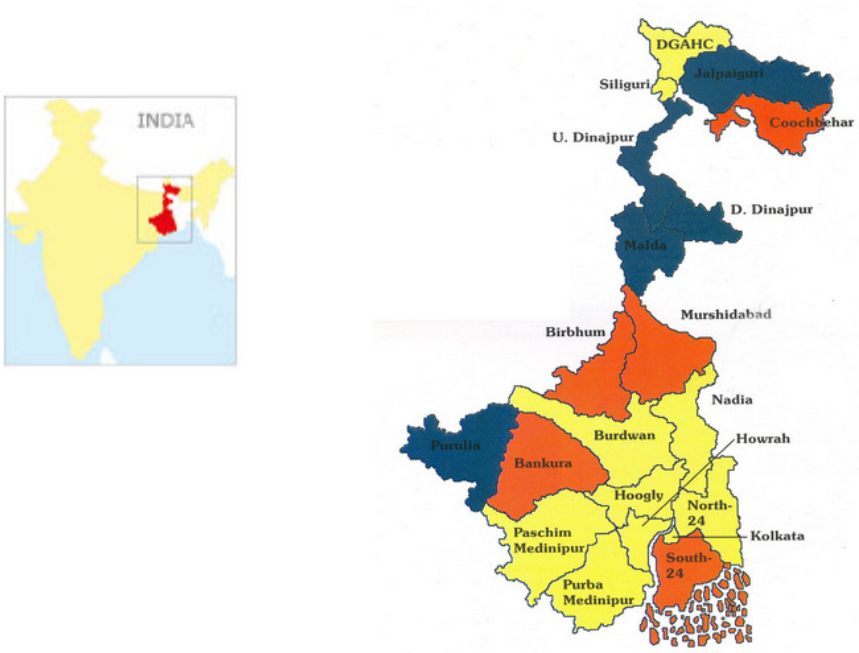

Figure-1
Showing the study area- Kolkata, India

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. Student's 't' test was applied between the groups for comparison of data.

Results and Discussion

Mean values ± SD of anthropometric and lung function test parameters along with level of significance are illustrated in table 1. Height, weight and body mass index (BMI) as shown in the table 1 were not significantly different in 2003 and 2013 studies. All lung function test parameters (FVC, FEV_1 and MVV) were observed to be lower in the overall population of 2013 in comparison to those collected in 2003. The decline in case of FVC was significant ($p<0.01$) in all age groups excepting the youngest one (i.e. 20-24 years). The difference in FEV_1 was significant in both 25-29 yrs and 30-34 yrs age groups. On the other hand, MVV values were significantly lower in all age groups of 2013 compared to 2003.

The two cross-sectional populations were studied 10 years apart. They were from the same locality. Their lung function parameters were compared between individuals matched for age groups. The strict assortment criteria for the volunteers assisted to minimize the variables that may influence the lung function test. Observed decline of lung function over last decades appeared to be valid. It is observed from table–1 that the height, weight and BMI are not significantly different, which indicates that physical features might not have varied significantly in young females of that particular region during last 10 years. Consequently, subjects were comparable regarding their physical activity, socioeconomic status and they were also from similar race and ethnic origin. However, there were some marked differences in the results of lung function study of the groups between studied in 2003 and 2013. In reference to the study by Doijad and Surdi[19] on Indian female, it was observed that the mean FVC, MVV values those recorded in 2003 were fairly comparable to the data obtained from their study.

The present study also exposed the fact of effect of some aspects on lung function on young female. While it is difficult to mention a specific reason for the difference, ambient air pollution and also the changes in lifestyle and habitual activities might be probable causes. The socioeconomic factor may not be considered to have contributed significantly because it is unlikely that there have been a negative socioeconomic growth in last ten years. However, the results at huge recommend the affect of increasing atmospheric pollution on lung function and possible negative stress of increasingly sedentary lifestyles. The decline of respiratory performance by air pollution due to automobile exhaust is well-evidenced[20,21] and congested Kolkata city is facing problem regarding exponential increase in number of automobile during last two decades. Transport sector is contributing major part of the total air pollution (Department of Environment, Government of West Bengal and West Bengal Pollution Control Board, 2002). A study carried out on air quality of Kolkata exposed RSPM level has been raised regularly from 2002 to 2007. So, it is the fact that increase in air pollution might have played a significant role in reducing respiratory performance. A study by Peters *et al.* [22], PM10, PM2.5, and NO_2 were each significantly correlated with lower FVC, FEV_1 and maximal midexpiratory flow (MMEF) in Southern California public school children. Gauderman *et al.*[23] suggested that exposure to air pollution may lead to a decline in maximal achieved lung function, which comes about early in adult life, and ultimately increase risk of chronic respiratory illness in adulthood. In more recent studies[24,25] with eight years follow up, it revealed that contact of children to roadways adversely affected growth of lung function during the period 10 to 18 years of age and resulted declining in lung function attained in the later part of life[25]. According to Matković *et al.*[26] decreased ventilatory functions of women is associated with a long-term exposure to increased air pollution.

Table-1
Showing Mean±SD along with level of significance of difference in anthropometric and lung function test parameters of different age groups obtained in the year 2003 and 2013

Parameters	Year	Age groups (years)					
		20-24 (years)		25-29 (years)		30-34 (years)	
		Mean±SD	Level of significance	Mean±SD	Level of significance	Mean±SD	Level of significance
Height (cm)	2003	153.94±6.1	NS	155.45±5.53	NS	155.32±5.42	NS
	2013	154.01±4.65		154.99±4.64		155.92±4.32	
Weight (kg)	2003	54.11±9.49	NS	56.68±5.52	NS	57.86±5.29	NS
	2013	54.81±7.39		57.26±4.76		58.26±5.19	
BMI(kg/m^2)	2003	22.83±3.62	NS	23.62±2.20	NS	24.01±2.24	NS
	2013	23.13±2.40		23.86±1.45		23.98±1.65	
FVC (L)	2003	2.85±0.41	NS	2.78±0.36	p<0.01	2.53±0.56	p<0.01
	2013	2.61±0.45		2.08±0.34		2.06±0.55	
FEV_1(L)	2003	2.30±0.50	NS	2.29±0.33	p<0.01	2.02±0.50	p<0.01
	2013	2.10±0.45		1.70±0.32		1.68±0.51	
MVV (L/min)	2003	96.26±20.5	p<0.01	90±18.2	p<0.01	89.5±16.2	p<0.01
	2013	85.2±19.8		81.3±17.9		80.3±17.5	

Further, several studies[27,28] have pointed out the effect of regular physical exercise in improving lung function performance mainly of the young. In the present study, females of 25-34 years age group in particular was affected more than the other age groups and showed deterioration of FVC, FEV_1 and MVV (table 1). On the other hand, there were no significant differences in FVC and FEV_1 in younger age group of 20-24 years. Although, to point out any specific cause for this exception is really difficult; the inactive life style probably have affected negatively the development of the lung function during early life which, in turn, have affected the respiratory performance of 25-34 years age group of the population. It is likely that, since school days, this age group have mostly shifted from outdoor sports and games to more passive forms of recreational activities and thus living a comparatively sedentary lifestyle. The overall merged effect of such factors seemed to be probable reason for diminution of respiratory performance especially in 25-34 years age group of population in this study.

Conclusion

From the study, it might be concluded that overall deterioration of lung function parameters in 2013 compared to 2003 might be due to increased environmental pollution, lack of physical activity. It might be recommended reduced air pollution along with active lifestyle may avert further negative growth of respiratory performance.

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