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DECLINE IN RESPIRATORY PERFORMANCE OF VARANASI POPULATION IN 22 YEARS : A CROSS-SECTIONAL STUDY

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Abstract : Lung function tests were performed on apparently healthy, non-smoking male volunteers aged 16–50 years normally staying in Varanasi city area. The volunteers were divided into five groups according to their age (16–19 yr, 20–25 yr, 26–30 yr, 31–35 yr, 40–50 yr). Anthropometric determinants (height and weight) and respiratory performance (vital capacity and peak expiratory flow rate) were recorded in the year 1982 and 2004. No significant (P>0.05) difference in height, weight and body mass index was detected between the age matched groups in the year 1982 and 2004. The Vital capacity (VC) was measured in 483 and 387 volunteers in the year 1982 and 2004 respectively; peak expiratory flow rate (PEFR) was measured in 200 and 388 subjects in the year 1982 and 2004 respectively. Both VC and PEFR were found to be reduced in the year 2004 as compared to those measured in 1982 from the similar population matched for age groups. They were significantly (P<0.001) lower (20–23% less for VC and 4–14% less for PEFR) in the 20–30 years age group. There was also significant (P<0.05) decrease in PEFR for the population of 16–19 years age group studied in 2004 compared to that of 1982. Significant (P<0.001) deterioration in VC per meter of height was observed in the population above 20 years of age. The mean values of VC (ml/m height) ranging from 2119.27 ± 316.64 (20-25 years age group) to 1923.29 ± 225.43 (40-50 years age group) in 1982 have dropped to 1896.54 ± 289.50 and 1593.64 ± 419.36 for the respective age groups in 2004. Similarly, mean value of PEFR (L/min) was found to be reduced from 523.67 ± 64.69 in 1982 to 471.44 ± 85.25 in 2004 for the same age groups of 20-25 years. Similar reduction was also recorded for 16–19 yr group and 26–30 yr group of population. Air-pollution and sedentary lifestyles in the population of this city may be probable reasons for the decline in respiratory performance.

Key words : vital capacity PEFR air-pollution lung function Varanasi

INTRODUCTION

Lung function parameters in an apparently healthy nonsmoker male population are subject to influence of atmospheric pollution levels (1, 2, 3), physical activity patterns (4, 5, 6, 7, 8), socioeconomic and nutritional status (9, 10) and other factors like age, sex, height, weight, race etc. (11, 12). Over the last two decades,

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the air pollution had been of great concern in Indian cities including Varanasi (13, 14). Moreover, Varanasi experienced a remarkable growth in motor vehicle traffic without desirable monitoring of the emission (15, 16). Available data (16, 17) indicates that vehicle registration as well as suspended particulate matters in air of Varanasi has increased more than that of similar cities in this region of the country. Pollution & Economic Research Laboratory, Center for Advance study of Botany, Banaras Hindu University, Varanasi revealed about the increasing amount of sulfur dioxide, nitrogen dioxide, carbon monoxide and respirable suspended particulate matters (RSPM) known to affect respiratory performance (18, 19, 20). Further, lifestyle and socio-economic factors are expected to have altered in various cities of India including Varanasi. Whether these changes are reflected in lung function of individuals was the subject of this cross-sectional population study performed at an interval of 22 years in the similar population of Varanasi city. The primary aim of this study was to compare the respiratory performance assessed by recording of vital capacity (VC) and peak expiratory flow rate (PEFR) in the year 1982 and 2004 from a selected healthy, asymptomatic, nonsmoker male population between age group of 16–50 years belonging to Varanasi.

MATERIAL AND METHODS

Male nonsmoker volunteers were selected from the visitors visiting the health exhibition held adjacent to the Departmental laboratory in the Institute of Medical Sciences, Banaras Hindu University, Varanasi in the last week of February or 1st week of March (day time temperature 25–27°C). A detailed clinical history was obtained and clinical examination was performed before the volunteers were selected for the pulmonary function tests. Smokers, asthmatics, obese individuals and persons with history of any recent illness or having history of any cardiopulmonary disease were not included in this study. The selected subjects were of sedentary workers comprising mostly students, teachers of school, office workers and small business man belonging to middle socioeconomic class. People with regular physical activity or industrial workers were excluded from this study. After being assured that the volunteer population was healthy, asymptomatic and normally resident of Varanasi, they were subjected to lung function tests for measurement of vital capacity (VC) and peak expiratory flow rate (PEFR). The recording was carried out every day between 11:00 AM to 4:00 PM to reduce the factor of diurnal variation.

VC was measured by using spirometer (INCO, India) and PEFR was recorded by Wright's mini peak flow meter in standing posture. In this study, a pre-calibrated standardized spirometer was used following the guidelines of American Thoracic Society (21). The spirometric maneuvers were repeated three times at the intervals of 5 minutes. The best of the three recordings was considered for analysis purpose. The equipment used in 1982 and 2004 was not the same one. The one used in 2004 was new but the model and manufacturer remained same. Appropriate pre-calibration of spirometers ensured the reliability and validity of the data collected.

Vital capacity (VC) was measured in 483 subjects in 1982 and in 387 subjects in 2004; PEFR was measured in 200 subjects in 1982 and in 388 subjects in 2004. Data of only healthy nonsmoking males aged 16 to 50 years of age and normally residing in Varanasi city was considered for analysis. Normality test (Kolmogorov-Smirnov) was performed for all sets of data. Student's t-test, unpaired two-tailed, was applied between the groups for comparison of data within normal distribution and non parametric test like Mann-Whitney Rank sum test was applied in case of data not following normal distribution. All the statistical tests were performed using Sigmastat software. Since the VC is largely dependant on height, it is expressed per meter of height to avoid any additional variable. The PEFR values were found to be poorly co-related with height (r = 0.037) in the present study therefore they are not expressed per meter of height.

RESULTS

The mean height, weight and body mass index (BMI) as shown in the Table I were not significantly different in 1982 and 2004 studies. Both VC and PEFR were observed to be lower in the overall population of 2004 in comparison to those collected in 1982. (Table II). The mean VC in 1982 ranged from 1923–2176 ml/meter of height for 16–50 years of age and declined to 1896–1593 ml/m of height in 2004 for the same age groups. The decline was significant (P<0.001) in all age

TABLE I : Showing Mean±SD values of height, weight and BMI of different age groups obtained in the year 1982 and 2004.

Measurements	*Year*	*Age groups (years)*				
		16–19	*20–25*	*26–30*	*31–35*	*40–50*
Height (cm)	1982	165.17±6.47	167.40±6.18	168.82±6.01	165.27±6.04	164.19±6.68
	2004	166.18±6.21	167.85±5.44	165.91±6.31	164.49±7.05	165.36±6.92
Weight (Kg)	1982	51.56±6.69	54.92±7.59	59.98±11.21	58.53±7.24	58.49±9.85
	2004	52.94±7.87	56.87±8.67	59.24±9.79	56.71±9.68	63.80±11.80
BMI (Kg/m^2)	1982	18.90±2.21	19.56±2.14	20.97±3.30	21.41±2.23	20.51±5.86
	2004	18.95±1.83	19.61±2.20	20.88±2.59	22.11±3.97	23.41±3.35

TABLE II : Showing comparison of Mean±SD values of Vital capacity/meter of height and PEFR (peak expiratory flow rate) L/min obtained from different age groups in the year 1982 and 2004.

Lung function	*Year*	*Age groups (years)*				
		16–19	*20–25*	*26–30*	*31–35*	*40–50*
VC (ml/m height)	1982	2029.02±371.57 (n=104)	2119.27±316.64 (n=303)	2176.79±353.37 (n=44)	2171.75±271.81 (n=14)	1923.29±225.43 (n=18)
	2004	1896.54±289.50 (n=35)	1873.9±83.77** (n=148)	1735.35±314.75** (n=79)	1674.79±309.19** (n=42)	1593.64±419.36** (n=83)
PEFR (L/min)	1982	498.52±62.95 (n=27)	523.67±64.69 (n=127)	520.68±81.07 (n=22)	500.00±74.26 (n=11)	442.69±92.66 (n=13)
	2004	458.71±90.30* (n=35)	471.44±85.25** (n=149)	451.85±80.85** (n=80)	450.00±81.45 (n=43)	431.11±97.64 (n=81)

*P<0.05; **P<0.001 as compared between the data obtained in year 1982 and 2004. The number of subjects is provided in the parenthesis.

groups excepting the youngest one (i.e. 16–19 years), and the worst affected group (20–23% less) was 26–35 years (Table-II). On the other hand, the mean PEFR values were nearly between 500–520 L/min in the population up to 35 years of age in 1982. On an average, the same values reduced by 50–70 L/min in the year 2004. The difference in PEFR was significant in younger age groups (16–30 yr) with 8–14% decrease.

DISCUSSION

The two cross-sectional populations studied 22 years apart were from the same locality and their lung function parameters were compared between individuals matched for age groups. The strict selection criteria for the volunteers helped to minimize the variables that may affect the respiratory performance. Therefore, observed deterioration of lung function over two decades seems to be valid. The height, weight and body mass index (BMI) as shown in the table I are comparable for both the time and not significantly different, indicating that physical features might not have changed significantly in males of this region during last 22 years. VC and PEFR values of 1982 population were similar to those reported by others (22). The PEFR values of 1982 population were also matching with contemporary reports for Indian population (11). The PEFR values of 2004 population were similar to those reported for various occupational exposures (23, 24). In a review (25) it was pointed out that PEFR values from various studies were similar and were around 544 L/min in 20–25 year age group population with maximum value attained by this age group. In reference to these studies it was observed that the mean PEFR value was slightly higher than those recorded in this study in 1982 but fairly comparable to the data obtained for control subjects in other studies conducted in Varanasi (4) and also maximum value was attained by similar age group in the present study. Although the average respiratory performance might not vary between North Indian and South Indian population (26) but a variation in a highly selected and specific group of population can not be ruled out, as depicted by the present study. While it is difficult to clinch a specific cause for the observed difference, atmospheric pollution and lifestyle changes are likely factors. The socioeconomic factor is unlikely because it is difficult to believe that there was a negative socioeconomic growth in last twenty two years even in this relatively slow progressive region of the country. VC is determined by lung dimensions, compliance and respiratory muscle power, whereas PEFR is determined mainly by airway caliber, alveolar elastic recoil and respiratory muscle effort. These determinants of lung function parameters could not be specifically investigated in the present work. However, the results at large suggest an influence of increasing atmospheric pollution on airways and possible negative influence of increasingly sedentary lifestyles. The reduction of respiratory performance by air pollution due to automobile exhaust is well known (2) and overcrowded Varanasi city has experienced exponential growth of automobile users during past two decades. Vehicle registration in Varanasi was increased by 750% during 1985 to 2002 and during similar period the vehicle increase in neighboring Patna has been recorded around 550% (16). Only in one year i.e. from year 2000 to 2001 the annual average suspended particulate matters (SPM) increased by 37% (from 312 $\mu g/m^3$ in the year 2000 to 428 $\mu g/m^3$ in 2001) in the residential area of Varanasi and data for RSPM and SPM in other years are not available due to irregular monitoring (16). The estimated average annual level of SPM (428 µg/m^3) in residential area of Varanasi city 2001 was far above the national annual ambient air quality standard for residential areas i.e. 140 µg/m^3 for SPM (13). Therefore, it is possible that rise in air pollution might have played a crucial role in reducing respiratory performance. A three year follow up study on lung function in Austrian children demonstrated that children exposed to <10µ suspended particulate matters with mean concentration as low as 20 µg/m^3 negatively affected forced vital capacity and mid expiratory flow rate (27). In more recent studies (28, 29) with eight years follow up, it was shown that exposure of children to major roadways adversely affected lung function growth during the period 10 to 18 years of age and this could result in important deficit in lung function attained in the later part of life (28). It was also reported that deficits of growth in FEV1 was associated with exposure to SPM, NO_2 and other automobile emissions (29, 30).

Further, earlier studies (4, 6, 7, 8) have emphasized the role of physical exercise in improving respiratory performance mainly of the young. In the present study the age group of 20–30 years was particularly more affected as these groups showed deterioration of both VC and PEFR (Table-II) but sparing relatively younger age group of 16–19 years who did not show significantly ($P>0.05$) altered VC. However, it is difficult to ascertain any specific reason for this exception; a number of attractive TV channels available almost in every home might have facilitated the sedentary life style and negatively affected the development of the ventilatory apparatus during early part of life which is reflected in 20–30 years age group of the population. The VC/meter of height had dropped by 12–23% in the population more than 20 years of age in 2004 (Table II) in the present study. It may be speculated that during first two decades during their developmental stage, since their school days, this age group have largely shifted from outdoor sports to more passive forms of entertainment like watching TV and thus decreasing their physical activity levels in daily life. Moreover, after-school study coaching has increasingly encroached on their afternoon sports over the last two decades or so. The overall combined effect of such factors seemed to be probable cause for reduction in respiratory performance (VC and PEFR), especially in 20–30 years age group of population in this investigation.

In conclusion, it might be presumed that because of increased environmental pollution, lack of physical activity and comparatively slow socioeconomic progress in this part of country, the younger section of adult male population of the year 2004 had lower values of VC and PEFR in comparison to those from the similar population of the year 1982. It may be suggested that encouragement for physical activities and healthier living conditions with reduced automobile air pollution may prevent further negative progress of respiratory performance.

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