THE EFFECT OF LONG-TERM EXPOSURE TO PARTICULATE POLLUTION ON THE LUNG FUNCTION OF TEHERANIAN AND ZANJANIAN STUDENTS

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Background: There is emerging evidence that particulate pollution also contributes to lung function decline; decline in lung function has been reported across Europe. The objective of this study was to evaluate the effect of long term exposure to particulate pollution on the adult lung function. **Methods**: Among 275 new students entrance of ZUMS, 28 Tehranian students (T.S) and 32 Zanjanian students (Z.S) were selected among healthy and non-smoker female students. FVC, FEV_1, $FEF_{25-75\%}$ and FEV_1 / FVC in two groups were measured and statistical analysis of data was performed by analysis of Covariance (ANCOVA) using SPSS Software, version of 11.5 and T-test. A minimum significance level of $p < 0.05$ was used for all comparisons and $p < 0.05$ was considered as significant changes. **Result:** Particulate pollution reduced FVC, FEV_1, and $FEF_{25-75\%,}$ measurably, on the contrary FEV_1 / FVC increased considerably. Vital capacity in T.S was 8.2 percent less than group Z.S, FEV_1 and $FEF_{25-75\%}$, were respectively 8.6 and 1 percent in T.S less than group Z.S, and FEV_1 / FVC in T.S was 1.5 % more than Z.S. **Conclusion:** Patterns of abnormalities in pulmonary tests are similar to other restrictive pulmonary disease. About 19% reduction in vital capacity in T.S confirmed that, long-term exposure to particulate pollution could create restrictive state with similar mechanism. Long-term exposure to particulate pollution threatens children lung growth and function.

Key words: $FEF_{25-75\%}$, FEV_1, FEV_1 / FVC, FVC, Particulate pollution

INTRODUCTION

Pollution is a worldwide problem and its potential to influence the physiology of human populations is great. Pollution can be made by human activity and by natural forces as well. Human exposure to pollution is believed to be more intense now than at any other time in human existence.[1] High air pollution levels have been linked to infant mortality. An early example is the London Fog episode of 1952, where a sharp increase in particulate matter (PM) air pollution led to increased mortality among infants and older adults.[2] There is mounting evidence that air pollution has chronic, adverse effects on pulmonary development in children. Longitudinal studies conducted in Europe and the United States have demonstrated that exposure to air pollution is associated with reductions in the growth of lung function, strengthening earlier evidence based on cross-sectional data.[3] Decline in lung function has been reported across Europe, there is emerging evidence that particulate pollution also contributes to lung function decline.[4] In recent years, epidemiological studies have shown association between ambient particulates matter concentration and health. Exposure to increased levels of particulate matter concentrations is related to increased mortality and a number of pulmonary effects, both acute and chronic.[5,6] The Swiss Study on Air Pollution and Lung Disease in Adults (SAPALDIA) published a -3.14% decrease in forced vital capacity (FVC) per 10 microg x m(-3) increment in particulate matter (particles with a 50% cut-off aerodynamic diameter of 10 micro (PM_{10}). Compared to the within-subject variability of FVC, the effect may be considered small.[7] Particulate matter (PM) in the air includes total suspended particles (TSP), particulate matter with median aerodynamic diameter less than 10 ?m (PM_{10}), particulate matter with median aerodynamic diameter less than 2.5 ?m ($PM_{2.5}$),fine and ultra fine particles, diesel exhaust, coal fly-ash, mineral dusts (e.g. coal, asbestos, limestone, cement), metal dusts and fumes (e.g. zinc, copper, iron, lead), acid mists(e.g. sulphuric acid), fluoride particles, paint pigments, pesticide mists, carbon black, oil smoke and others. [8] U.S. Environmental Protection Agency established an annual average air quality standard for $PM_{2.5}$ of just 15 $\mu g/m^3$ in 1997, annual average air quality standard for PM_{10} of just 50 $\mu g/m^3$.[9] Tehran, the capital city of Iran, is situated on a plain south of the Alborz Mountains. Tehran is one of the largest cities in the world. Tehran is one of cities in terms of environmental pollution, caused by industrial processes and urban activities. The rate of air pollutants in Tehran is 8.2 times more than world standard. The monthly average of PM-10 in Tehran is high in autumn and low in spring. Maximum average value observed in September is over 370 microg/m^3; the minimum in March (102 microg/m^3) and early April (65 microg/m^3).[10,11] Zanjan in northwestern Iran, is located 320 km northwest of Tehran and near the Caspian Sea in Zanjan province, of which it is the capital. Zanjan lies on a valley of the Zagros Mountains, with a present day population of 400.000 and annual average for $PM_{2.5}$ is less than 15 µg/m^3 and annual average for PM_{10} is less than 50 µg/m^3. The objective of this study was to evaluation the effect of particulate pollution on the adult lung function; hence FVC, FEV_1, $FEF_{25-75\%}$ and FEV_1 / FVC in two groups of Tehranian and Zanjanian students were measured.

MATERIAL AND METHODS

This study was conducted over a period from March 2005 to march 2006. Subject participation was approved by the University of Zanjan Institutional Review Board for Human Studies; principles of the Declaration of Helsinki as well as to Title 45, U.S. Code of Federal Regulations, Part 46, Protection of Human Subjects, Revised November 13, 2001, effective December 13, 2001 were followed in this study. Satisfaction was acquired from students before conducting spirometery test. Considerable parameters include: location of residency, sex, height, weight, FVC, FEV_1, $FEF_{25-75\%}$ and FEV_1 / FVC. After new student's entrance to Zanjan University of Medical Sciences in September 2005, sampling was done by easy non-probability sampling and two groups of students **[**Tehranian student (T.S) and Zanjanian student (Z.S)**],** were selected for study. The general conditions of students who were selected as our samples include: no history of asthma, respiratory diseases, smoking, professional exercise and working in mines, factory and working place with contamination by particulates matter and chemical substances, and BMI range between 20-25. As the most of new student's entrance to Zanjan University of Medical Sciences were female, we have to select the subjects among female students. Questionnaire forms were filled by students and samples were selected among 275 of new students, 62 students had appropriate condition for this study, 2 students dispensed and finally 60 female students were selected for study T.S Group consists of 28 tehranian students who were born in Tehran and continued living there for 18-23 years with and Z.S Group consists of 32 students with similar conditions like T.S Group, whose location of residency was in Zanjan and continued living in Zanjan for 18-23 years. Spirometery test was conducted by a professional technician with a Spiro-analyzer model ST-300 (Tokyo, Japan). Two months after moving Tehranian students to zanjan spirometery test was done on both groups. Before conducting spirometery test, the spirometer was calibrated, after recording personal information, the students were requested for conducting forced vital capacity and the largest one was considered for evaluation. The instrument determined three quantities for each parameter in three columns. In the first column, the real amount of each parameter stated as the related unite (MEAS). In the second column, in relation with initial information include: age, sex, height, weight, race and other parameter for each person, the instrument stated predicted amount (PR) on the basis of table, references and special formulas. In the third column, the instrument stated the ratio of measured amount to predicted amount as percent and recorded as (%PR). The obtained information by spirometery and questionnaire were recorded in computer, statistical analysis of data was performed by analysis of Covariance (ANCOVA) with the help of SPSS Software, version of 11.5. The central identical, dispersion, T-test and non-parametric kolmogorove simirinove test. A minimum significance level of $p < 0.05$ was used for all comparisons and $p < 0.05$ was considered as significant changes.

RESULTS

The students were aged 18-23 years and the mean age of students was 19.5 $\pm$ 1.1 years. Their height was 145-172 cm and the mean height of students was 160.9 $\pm$ 6.8 cm. Their weight was 45-80 kg and the mean weight was 57.5 $\pm$ 7.7 kg. The mean measured amounts of FVC, FEV_1, $FEF_{25-75\%}$ and FEV_1 / FVC were reported in table 1-1.

Mean measured amounts of FVC, FEV_1,$FEF_{25-75\%}$ and FEV_1 / FVC divided to predicted amounts for the same parameters was calculated and the result of this division was stated in percentage and reported in table 1-2.

Change in FEV_1 was considerable in T.S, while this change in Z.S was inconsiderable. Change in $FEF_{25-75\%}$. in two groups was inconsiderable. Particulate pollution increased FEV_1 / FVC, change in FEV_1 / FVC in two groups was considerable, the amount of FEV_1 / FVC in T.S was 1.5 % more than Z.S. The mean difference percentage to normal amounts for FVC, FEV_1, $FEF_{25-75\%}$ and FEV_1 / FVC was calculated and reported in table 1-3.

Table -1: Compares mean measured parameters in different groups

Groups	FVC(L)	FEV_1(L)	$FEF_{25-75\%}$ (L/S)	FEV_1 / FVC
T.S	2/50 ± 0/50	2/49 ± 0/50	4/59 ± 0/93	99/82 ± 0/005
Z.S	2/75 ± 0/54	2/73 ± 0/53	4/62 ± 0/93	99/56 ± 0/01

Table-2: The ratio of mean measured parameters to predicted parameters in different groups stated in percentage

Groups	FVC(L)	FEV_1(L)	$FEF_{25-75\%}$ (L/S)	FEV_1 / FVC
T.S	80/79 ± 18/47	91/28 ± 19/89	98/00 ± 26/10	113/15 ± 2/29
Z.S	88/47 ± 15/98	99/92 ± 17/07	98/97 ± 26/23	112/64 ± 2/32

Table-3: Compares the mean difference percentage to normal percentage for each parameter

Groups	FVC(L)	FEV_1(L)	$FEF_{25-75\%}$ (L/S)	FEV_1 / FVC
T.S	19/21 ± 18/47	8/71 ± 19/89	2/00 ± 18/95	13/14 ± 0/43
Z.S	11/02 ± 15/99	0/07 ± 17/70	0/02 ± 19/19	12/65 ± 0/17

DISCUSSION

The present study produced several key finding in relation with long-term exposure to particulate pollution on the lung function. First, long-term exposure with particulate pollution associated with reduction in vital capacity and growth of lung, about 19% reduction in vital capacity in T.S resulted in continuous exposure with particulate pollution in Tehran. There was a direct relationship between particulate pollution rate and decline in lung function. Particle pollution in Zanjan is lower than Tehran and decline in vital capacity and lung function in Z.S is lower than T.S. Second, particulate pollution have measurably slower FEV_1 and $FEF_{25-75\%}$, changes in FEV_1 was considerable in T.S, while these changes in Z.S was inconsiderable and changes in $FEF_{25-75\%}$ in two groups were inconsiderable. Third, an increase in FEV_1 / FVC was observed in two groups, changes in FEV_1 / FVC in two groups were considerable and this increase in T.S was more than Z.S. Ackermann-Liebrich et al in 1997 reported that an increase of 10 $\mu g/m^3$ in particulate matter less than 10 µm in diameter (PM_{10}) resulted in a decrease of 3.4% in FVC and of 1.6% in FEV_1 in healthy non-smokers. Chestnut et al [in] 1991 reported that an increase of 34 $\mu g/m^3$ in total suspended particles was related to a decrease of 2.25% in FVC and that the change in FEV_1 was significant even though the change was small.[12] An increase of 10 $\mu g/m^3$ in PM_{10} exposure was associated with a decrease in growth of forced expiratory volume in 1 second of 84 mL/year. Avol et al in 2001 reported, subjects who moved to locations with higher PM_{10} concentrations showed lower rates of annual growth in lung function, and subjects who moved to locations with lower PM_{10} concentrations than they had left showed higher rates of growth in lung function. This effect was increased in subjects who lived in the new location for at least 3 years.[13] Calder?n-Garcidue?as et al in 2003 reported a significant seasonal drop in forced vital capacity (FVC) and FEV_1 associated with a 6-month period of high O_3 and PM_{10}.[14] In children, particulate pollution affects lung function and lung growth.[15] Exposure to PM_{10} affected lung growth, large and small airway development. The association between higher pollutant concentrations and reduced pulmonary function in this urban-rural comparison suggests that there is an effect of urban air pollution on short-term lung function and/or lung growth and development during the preadolescent years.[16] The association between ambient pollutants and poorer gain of pulmonary volumes in children living in more polluted areas suggests that air pollution in the residence area may be a part of the causal chain of reactions leading to retardation in pulmonary function growth during the preadolescent years.[17] Decline in lung function in relation with exposure to higher levels of particulate matter consequently fibrous tissue formation in the alveolar septa and fibrotic lesion of the small airways. The nasal turbulence mechanism for removing particles from air is so effective that almost no particle larger than 6 µm in diameter enter the lung through the nose. Of the remaining particles, many that is between 1-5 µm settle in the smaller bronchioles as a result of gravitational precipitation.[18] The lung is defended against particles by a system that includes the physical barrier posed by the upper airway that filter out larger particles, the mucociliary escalator that removes inhaled particles, and the alveolar macrophages that scavenge inhaled and deposited particles in the small airways and alveoli.[19] Bronchi are lined with a ciliated, columnar epithelium. Ciliated cells rhythmically beat in a thin, watery liquid layer produced by the epithelium and transport secreted mucus and inhaled particles toward the trachea, where they swallowed.[20] Cilia are present as far as the respiratory bronchioles, but gland are absent from the epithelium of the bronchioles and terminal bronchioles.[21] Respiratory filtration system could not entrap particulate matter with a size less than 2.5μm well, particles less than 1 μm pass the respiratory filtration system and enter the alveoli, diffuse against the walls of the alveoli and adhere to the alveolar fluid. An excess of particles can cause growth of fibrous tissue in the alveolar septa, leading to permanent debility.[22] The results of our study are in agreement with other findings, previous researchers emphasized that particulate pollution also contributes to lung function decline.[4] The future studies about the effect of particulate pollution should be done with all age groups, and we should pay attention on individuals who live in huge industrial cities for more than half of a century. There is emerging evidence that air pollution influence the physiology of human populations. Exposure to increased levels of particulate matter concentrations is related to increased mortality and a number of pulmonary effects, both acute and chronic. Long-term exposure to particulate pollution threatens next generation's lung growth and function.

CONCLUSION

Patterns of abnormalities in pulmonary tests are similar to other restrictive pulmonary disease. About 19% reduction in vital capacity in T.S confirmed that, long-term exposure to particulate pollution could create restrictive state with similar mechanism. Long-term exposure to particulate pollution threatens children lung growth and function.

ACKNOWLEDGEMENTS

This work was supported by Zanjan University of Medical Science, so the authors gratefully acknowledge the authorities of this university. 2005 new students entrance of Zanjan University of Medical Sciences cooperated with us for conducting this study; hence the authors would like to thank of these students.

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