Impact of Socioeconomic Status on Spirometry Reference Values among Children and Adolescents of Karachi

Sara Sadiq[1*], Syed Tousif Ahmed[2], Nadeem Ahmed Rizvi[2], Muzna Shah[1], Muhammad Fazal Hussain Qureshi[1] and Mahira Lakhani[1]

[1]*Department of Physiology, Ziauddin University, Karachi, Pakistan.*
[2]*Jinnah Postgraduate Medical Centre, Karachi, Pakistan.*

Authors' contributions

This work was carried out in collaboration between all authors. Author SS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors STA and NAR drafted and revised the manuscript critically for important intellectual content and gave final approval to be published. Authors MS, MFHQ and ML collected data and managed the literature searches. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Aim: The aim of the study is to assess the influence of socioeconomic status on the lung function among the children and adolescents of Karachi.
Study Design: The current study is a cross-sectional study.
Place and Duration of Study: Sampling was started in April 2017 and ended up in October 2017. The data were collected from different primary, middle, secondary and higher secondary schools of Karachi.
Methodology: The study participants enrolled were between the age group of 7-18 years. A modified form of International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire was used. All the spirometry variables were measured and interpreted, these including forced vital capacity, forced expiratory volume in 1 second, FEV_1/FVC, peak expiratory flow rate, forced

_____

*Corresponding author: E-mail: dr.sarabhatti@gmail.com;

expiratory flow between 25% and 75% expired volume. ANOVA was applied to evaluate group variation while intragroup variations were analyzed by using Post-Hoc Tukey's test.

Results: The pulmonary variables like FVC, FEV_1, PEF and FEF_{25-75} had a significant value with socioeconomic status, on the other hand, the ratio of FEV_1/FVC was presented as non-significant but fortunately it persisted higher than 90% among all groups. After applying Post-Hoc Tukey's test all the spirometry variables showed significant intra-group variations as *P* value was less than .05 mentioned.

Conclusion: It is concluded that the socioeconomic status of children should be considered during evaluation of lung function, especially in the settings of developing countries.

1. INTRODUCTION

Pakistan is a developing country with a poverty index of about 0.237 and the main contributor of deprivation in dimension to overall poverty are living standards, health and education [1]. Considering socioeconomic status (SES) as an important factor in relation to health-related issues and premature deaths, as there are some essential necessities for well-being including food, clean water, shelter and access to schools or employment [2]. The term SES is used to measure individual's or family's social or economic status in a social group [3,4] and is well documented about the improvement in health status with the upgrading of SES [5].

Pulmonary function tests are widely used to assess the lung function; among them, the Spirometry is the gold standard technique [6,7]. Multiple factors are responsible for the variations among the spirometry reference ranges, including age, sex, anthropometric variables like height and weight, genetic factor, ethnicity and beside all, SES is also one of the important factor [8,9]. It is well documented that physical growth including height and weight has an influence over the lung development and function. Looking specifically over the pediatrics' age group, the growth depends upon the SES, as it is linked to the pre as well as post-natal nutrition so indirectly influence the height and weight of the child [10-12].

Poverty and nutritional status are important factors in the development of lung among children than adults. So the aim of current study is to assess the influence of SES over the lung function among the children and adolescents of Karachi.

2. METHODS

The current study is a cross-sectional study, the participants were the children and adolescents of age between 7-18 years. An ethical review committee of Ziauddin University and Hospital had approved the current study. Sampling was started in April 2017 and ended up in October 2017. The data were collected from different primary, middle, secondary and higher secondary schools of Karachi, selected by using multistage sampling technique. On the basis of SES, 8 schools were selected randomly. SES was defined as the lower SES with income between Rs4,000 and less to as much as Rs50,000 and less per month, middle SES with income between Rs50,000 to Rs100,000 and less per month while income with more than Rs100,000 enrolled in upper class. After taking schools, students were selected randomly, considering the age groups of the study participants. Consent was taken from the Principal of school and parents as well, on the other hand assent were obtained from the participating students.

Those children and adolescents were excluded from the study who (1) was less than 7 years of age (2) had traumatic history with abnormality in respiratory system (3) was diagnosed case of respiratory tract diseases like asthma, allergic rhinitis, wheezing (4) was diagnosed case of congenital heart diseases, (5) had muscular disorders including Duchene muscular dystrophy (6) was on bronchodilator therapy (7) had any deformity of chest wall (8) was a smoker. A modified form of International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire was used before measuring the lung function. After that, a Doctor did the general physical and systemic examination of all the participants.

Lung volumes were measured by using Vitalograph-alpha (spirometer). It was calibrated before the initiation of procedure. American thoracic society/European respiratory society (ATS/ERS) task force 2005 standardization guidelines were followed. All the spirometry

variables were measured and interpreted, these including forced vital capacity (FVC), forced expiratory volume in 1 second (FEV_1), FEV_1/FVC, peak expiratory flow rate (PEF), forced expiratory flow between 25% and 75% expired volume (FEF_{25-75}).

Participants were comfortably sitting on the chair during the whole procedure, spirometry was done by applying nose clip to avoid misinterpretation. Spirometry was performed three to eight times and the best of them were noted for analysis.

Statistical program for social science (SPSS) version 20 were used for analysis. All the qualitative variables were mentioned in frequency and percentages while quantitative variables as mean and standard deviation. ANOVA was applied to evaluate group variation while intragroup variations were analyzed by using Post-Hoc Tukey's test. Data were considered as statistically significant if $P < .05$. The linear regression equation was calculated for all spirometry variables.

3. RESULTS

A total of about 812 participants were included in the study, after excluding some of them because of unsatisfactory results, about 751 were taken for final analysis in which 64.4% were boys while 35.6% were girls. The mean age of the participants was 12.96 ± 2.8 years among them

boys were of 13.1 ± 2.7 years while girls with 12.66 ± 2.8 years. The mean height of the study participants was 150.2 ± 15.8 cm while weight was 44.2 ± 16.6 Kg.

The main characteristics of study participants along with spirometry variables including FVC, FEV_1, FEV_1/FVC PEF and FEF_{25-75} with reference to different socioeconomic groups are shown in Table 1, all of them were presented as mean ± standard deviation. It is well presented in the table that as SES going down unfortunately the pulmonary function decreases as well. The children and adolescents of lower class of SES showed lower test results that is the indicator of poor lung health.

The pulmonary variables like FVC, FEV_1, PEF and FEF_{25-75} had a significant value with socioeconomic status, on the other hand, the ratio of FEV_1/FVC was presented as non-significant but fortunately it persisted higher than 90% among all groups. Boys having higher spirometry values than the girls among all groups of SES. After applying Post-Hoc Tukey's test all the spirometry variables showed significant intra-group variations as *P* value was less than .05 mentioned in Table 2. Regression analysis was done by first finding out the correlation coefficient of all variables with the lung volumes. After that regression equation were calculated by considering the age and height along with SES as an independent variable.

Table 1. Characteristics of study participants among socioeconomic groups

Variables	Higher SES	Middle SES	Lower SES
Age (years)	13.28 ± 1.8	13.29 ± 2.9	12.2 ± 2.5
Height (cm)	158.2 ±10.5	151.1 ± 16.7	144.8 ± 14.0
Weight (Kg)	51.45 ± 12.6	46.29 ± 17.7	37.03 ± 12.7
Lung volumes			
FVC (L)	2.42 ± 0.54	2.26 ± 0.81	2.04 ± 0.67
FEV_1 (L)	2.31 ± 0.54	2.11 ± 0.79	1.91 ± 0.66
PEF (L)	244 ± 56.1	236 ± 75.5	216 ± 63.2
FEF_{25-75} (L)	2.76 ± 0.78	2.68 ± 0.89	2.45 ± 0.93

Table 2. Regression equation with p-values for socioeconomic groups

Variables	*P* value			Regression equation	R
	Higher SES	Middle SES	Lower SES		
FVC	.000	.001	.001	(-1.525)+0.235(A)+0.005(H)+(-0.03)(SES)	0.949
FEV_1	.000	.000	.005	(-1.468)+0.230(A)+0.004(H)+(-0.05)(SES)	0.940
PEF	.003	.001	.001	(-111.03)+21.2(A)+0.422(H)+1.84(SES)	0.909
FEF_{25-75}	.001	.002	.002	(-3.37)+0.361(A)+0.008(H)+0.105(SES)	0.909

A, age in years; H, standing height (cm); SES, socioeconomic status

4. DISCUSSION

Socioeconomic inequity is one of the indicator of health status [13]. Multiple studies reported high prevalence of intrauterine growth retardation due to poor nutritional status during pregnancy among low SES [14].

Lung function test among children is very essential to diagnose multiple respiratory tract diseases and for follow-up purpose. Looking over the Pakistan, none of the study has been done to establish a reference range or prediction equation among children and adolescents. So the current study is important to predict a reliable equation for considering SES along with age and height.

When looking over the south-east Asia, an Indian study showed a significant difference in lung function variables among different categories of socioeconomic status, as the lower SES showed poor lung function, the possible reason behind this is the malnutrition [15] and this support the current findings. A study from Bangladesh, another Asian country also reported lower FVC and FEV_1 as compare to their age mates of upper SES [16]. A comparison study done by Sonnapa et al. [17] considering the different SES with same ethnicity, reported the poor lung function among the children's of lower SES who were living in rural areas when comparing with the children of upper SES.

Literature review revealed contradictory findings from the developed countries like UK [18-20], China [21] and Malaysia [22] did not manifest any association between lung function and SES, the difference is due to intake of a balanced diet among children and adolescents of developed countries. On the other hand, a Canadian study showed significant difference in lung function of upper and lower SES but no difference in anthropometric variables [23]. One of the study done in African-American and white children concluded that SES played a negligible role among their population (24).

A study done in Denmark showed decrease in lung volumes specifically FVC and FEV_1 levels [25] and this favors the current study. Multiple studies reported a strong correlation between SES and smoking, as smoking rate increases with low income or education [26,27]. Wheeler et.al did a comparison study and reported that SES had greater influence over the lung function than the effect of air pollution but had less effect than the active smoking [28].

Developed countries considered ethnic variability as an important part of predicting equation but in developing countries like Pakistan and India there is a wide variation among the anthropometric as well as lung variables among the three different SES, highlighted its importance in prediction equation.

5. CONCLUSION

It is concluded that the socioeconomic status of children should be considered during evaluation of lung function, especially in the settings of developing countries. The prediction equation established in the current study can be used as a reference equation for the children and adolescents of Pakistan.

CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

As per international standard or university standard, written approval of Ethics committee has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Alkire S, Santos ME. Measuring acute poverty in the developing world: Robustness and scope of the multidimensional poverty index. World Development. 2014;59:251-74.

2. Isaacs SL, Schroeder SA. Class--the ignored determinant of the nation's health. The New England Journal of Medicine; 2004.

3. Porter D, Craig D. The third way and the third world: Poverty reduction and social inclusion in the rise of 'inclusive' liberalism. Review of International Political Economy. 2004;11(2):387-423.

4. Krieger N. A glossary for social epidemiology. Journal of Epidemiology & Community Health. 2001;55(10):693-700.

5. Adler NE, Ostrove JM. Socioeconomic status and health: What we know and what we don't. Annals of the New York Academy of Sciences. 1999;896(1):3-15.

6. Stanojevic S, Wade A, Stocks J. Reference values for lung function: Past, present and future. European Respiratory Journal. 2010;36(1):12-9.

7. Lum S, Bountziouka V, Quanjer P, Sonnappa S, Wade A, Beardsmore C, et al. Challenges in collating spirometry reference data for South-Asian children: An observational study. PloS One. 2016;11(4):e0154336.

8. Mohammed J, Maiwada SaA, Sumaila FG. Relationship between anthropometric variables and lung function parameters among primary school children. Annals of Nigerian Medicine. 2015;9(1):20.

9. Strippoli MPF, Kuehni CE, Dogaru CM, Spycher BD, McNally T, Silverman M, et al. Etiology of ethnic differences in childhood spirometry. Pediatrics. 2013;131(6):e1842-e9.

10. Hegewald MJ, Crapo RO. Socioeconomic status and lung function. Chest. 2007;132(5):1608-14.

11. Wolff PT, Arison L, Rahajamiakatra A, Raserijaona F, Niggemann B. Spirometric reference values in urban children in Madagascar: Poverty is a risk factor for low lung function. Pediatric Pulmonology. 2014;49(1):76-83.

12. Wong TW, Du L, Lin GZ, Gao Y, Jiang ZQ, Yu T, et al. Nutrition and children's respiratory health in Guangzhou, China. Public Health. 2008;122(12):1425-32.

13. Mackenbach JP, Stirbu I, Roskam AJR, Schaap MM, Menvielle G, Leinsalu M, et al. Socioeconomic inequalities in health in 22 European countries. New England Journal of Medicine. 2008;358(23):2468-81.

14. Kramer MS, Seguin L, Lydon J, Goulet L. Socio-economic disparities in pregnancy outcome: Why do the poor fare so poorly? Paediatric and Perinatal Epidemiology. 2000;14(3):194-210.

15. Raju PS, Prasad K, Ramana YV, Balakrishna N, Murthy K. Influence of socioeconomic status on lung function and prediction equations in Indian children. Pediatric Pulmonology. 2005;39(6):528-36.

16. Choudhury S, Alam M, Begum Q. Lung function parameters of Bangladeshi male subjects in different living conditions. Bangladesh Med Res Counc Bull. 1997;23(1):30-3.

17. Sonnappa S, Lum S, Kirkby J, Bonner R, Wade A, Subramanya V, et al. Disparities in pulmonary function in healthy children across the Indian urban–rural continuum. American Journal of Respiratory and Critical Care Medicine. 2015;191(1):79-86.

18. Lawlor D, Ebrahim S, Smith GD. Association between self-reported childhood socioeconomic position and adult lung function: Findings from the British women's heart and health study. Thorax. 2004;59(3):199-203.

19. Lunn J, Knowelden J, Roe J. Patterns of respiratory illness in Sheffield junior schoolchildren. A follow-up study. British Journal of Preventive & Social Medicine. 1970;24(4):223.

20. Shohaimi S, Welch A, Bingham S, Luben R, Day N, Wareham N, et al. Area deprivation predicts lung function independently of education and social class. European Respiratory Journal. 2004;24(1):157-61.

21. Chen Y, Li WX. The effect of passive smoking on children's pulmonary function in Shanghai. American Journal of Public Health. 1986;76(5):515-8.

22. Gharaibeh NS. Effects of indoor air pollution on lung function of primary school children in Jordan. Annals of Tropical Paediatrics. 1996;16(2):97-102.

23. Demissie K, Ernst P, Hanley JA, Locher U, Menzies D, Becklake MR. Socioeconomic status and lung function among primary school children in Canada. American Journal of Respiratory and Critical Care Medicine. 1996;153(2):719-23.

24. Harik-Khan RI, Muller DC, Wise RA. Racial difference in lung function in African-American and White children: Effect of anthropometric, socioeconomic, nutritional, and environmental factors. American Journal of Epidemiology. 2004;160(9):893-900.

25. Prescott E, Lange P, Vestbo J. Socioeconomic status, lung function and admission to hospital for COPD: Results from the Copenhagen City heart study. European Respiratory Journal. 1999;13(5):1109-14.

26. Control CfD, Prevention. Cigarette smoking among adults--United States,

2002. MMWR Morbidity and Mortality Weekly Report. 2004;53(20):427.

27. Stimpson JP, Ju H, Raji MA, Eschbach K. Neighborhood deprivation and health risk behaviors in NHANES III. American Journal of Health Behavior. 2007;31(2): 215-22.

28. Wheeler BW, Ben-Shlomo Y. Environmental equity, air quality, socioeconomic status, and respiratory health: A linkage analysis of routine data from the Health Survey for England. Journal of Epidemiology & Community Health. 2005;59(11):948-54.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/24516