ORIGINAL ARTICLE

VARIATION IN LUNG VOLUMES AND CAPACITIES AMONG YOUNG MALES IN RELATION TO HEIGHT

Urooj Bhatti, Keenjher Rani, Muhammad Qasim Memon

Department of Physiology, Liaquat University of Medical and Health Sciences, Jamshoro, Pakistan

Background: Vital Capacity (VC) is defined as a change in volume of lung after maximal inspiration followed by maximal expiration is called Vital Capacity of lungs. It is the sum of tidal volume, inspiratory reserve volume and expiratory reserve volume. Vital capacity of normal adults ranges between 3 to 5 litres. A number of physiological factors like age, gender, height and ethnicity effect lung volumes. The reference values of lung volume and capacities were calculated previously and those studies played pivotal role in establishing the fact that air volume capacities measured in an individual fall within a wide range among healthy persons of same age, gender and height but with different ethnicity. The objective of this study was to evaluate the changes in vital capacity in with height and gender. **Methods:** This cross-sectional study included 74 male students in the Department of Physiology, Liaquat University of Medical and Health Sciences, Jamshoro during January–March, 2014. The volunteers were divided into 2 groups of height ≤167.4 cm and >167.4 cm. The volunteers' height was measured in cm. Vital capacity of the subjects was measured using standard protocol. Mean±SD of age, height and vital capacity were calculated. **Results:** Mean vital capacity in students with height >167.4 cm was higher than average vital capacity of students with height ≤167.4 cm. It might be due to the increased surface area of the lungs in relation with increasing height. **Conclusions:** There are variations in vital capacity of individuals in relation to their heights, within the same ethnic and age groups.

Keywords: Height, Vital Capacity, Pulmonary Function Test, Spirometry

J Ayub Med Coll Abbottabad 2014;26(2):200–2

INTRODUCTION

Pulmonary function tests (PFTs) are widely used to measure the performance of lungs during physiological and pathological conditions. PFTs determine lungs capability of holding air, amount of air moving in and out and how well lungs take in oxygen and remove carbon dioxide from blood. These tests also measure pathology in lungs if any present and hence used as diagnostic tests for lung diseases. There are a number of diagnostic tests such as Residual volume, Inhalation challenge tests, Body plethysmography, Gas diffusion tests, and exercise stress tests, which help in defining status of lung functions. But spirometry being the most commonly performed lung function test, is considered as first choice in diagnosis of lung pathology. Spirometry is a technique used to measure amount and flow of air inhaled and exhaled and the lung function. It measures amount of air that can be moved in and out of one's lungs.[1]

Most measured entity of lung function is Vital Capacity; Change in volume of lung after taking maximal inhalation followed by maximal exhalation is called Vital Capacity of lungs. It is the sum of tidal volume, inspiratory reserve volume and expiratory reserve volume. Vital capacity of normal adults ranges between 3 to 5 litres. A number of physiological factors like age, gender, height and ethnicity show variations in pulmonary functions. The reference values so calculated play a leading role in establishing the fact that lung volume capacities measured in an individual fall within a wide range among healthy persons of same age, gender and height but with different ethnicity.[2]

Although there have been many studies done to compare any significant relation between height and vital capacities but such types of studies have been done long ago probably half a century ago, these values need to be revised again according to our race and ethnicity.

The aim of this study was to observe the variation in VC among same gender (young males, age 17–23) in relation to their height, performed on PowerLab®.

MATERIAL AND METHODS

This cross-sectional study was carried out in the Department of Physiology, Liaquat University of Medical and Health Sciences, Jamshoro. Students were requested to be a part of research study. Total 74 students participated. Predicted values were derived from calculated spirometric observations on PowerLab® before a prerequisite medical screening. The volunteers' height was measured on BMI scale (RGZ-160), all respiratory parameters were measured on PowerLab® (T-125, AD-Instruments, Australia).

Male students 17–23 years of age, BMI in normal range, i.e., 18–24, non-smoker and having no history of any cardiac or respiratory disease were included. Female students, male students with BMI >25,

smokers and those, having history of any cardiac or respiratory diseases were excluded.

A prerequisite medical screening session consisting of BMI, Electrocardiogram (ECG), and Blood Pressure (BP) was done before spirometry. Data were analysed using MS Excel. Mean±SD were calculated.

RESULTS

The vital capacity in male students with height >167.4 cm was 3.0±0.5 L. and with the height ≤167.4 cm the vital capacity was 2.9±0.4 L.

Table-1: Vital capacity of subjects in relation to height (Mean±SD)

Height	Age (Yr)	Height (Cm)	VC (L)
≤167.4 Cm	19.1±0.56	161.9±0.56	2.9±0.4
>167.4 Cm	18.4±0.52	168.6±0.52	3.0±0.5

DISCUSSION

The study reveals that the average vital capacity in taller male students (with height >167.4 Cm) was greater than the male students having height ≤167.4 Cm. Reason for this variation is that, with increasing height, chest girth and thoracic area is increased and hence total surface area of lungs is increased. In taller people there is more area for exchange of air is available than in shorter ones, and therefore greater amount of air can exchange in and out and this causes an increase in vital capacity of taller people. A tall individual may have a higher VC, FRC and TLC. A study from Nigeria showed that vital capacity increases with height.[3] This study is in agreement with the Nigerian study.

In order to explain correlations between vital capacities and physical parameters (height, weight, surface area and volume of thorax), many attempts have been made with the hope that accurate prediction of correlations would be made possible.[4] Sara Khan has also suggested the relationship between vital capacity and the cube of height among boys and girls of same height and BMI in Candian children.[5] Carey *et al* in his seven year longitudinal study revealed the negative relationship of weight with lung volumes.[6] According to American Thoracic Society, while interpreting pulmonary function test one must consider racial and ethnic differences. The fact is that process lung functional development occurs up to about 35 years of age and then it starts regressing.[7]

Several studies suggest that height is the best single standard of reference, but to be more accurate, the prediction of correlation is gained by references of age and weight in addition to height with preference to index of build or chest girth.[8] If the body physique of man and woman is similar then there should be little difference in their lung volumes. Linear equations which relate the lung volume and its subdivisions to standing height offer a simple means of measuring normal values of lung volumes and capacities without much sacrifice of accuracy, in limited ranges of height.[8]

Physiological, psychological and anatomical factors of individuals contribute to this alteration. Body mass index, height, weight and chest diameter are the variables that show alterations from individual to individual. It is important to consider biological variations while assessing lung functions.[9–12] Gender, body size, and age are some factors responsible for variations in lung volumes and capacities among individuals.[13–16] Studies suggest that ethnicity as an important factor also shows variability in lung volumes among individuals of same height, gender and weight.[9,13] Peter in his study stated that deviation of spirometric values from the calculated values can occur even when the best combination of physical factors are used.[17]

Out of a number of subdivisions of the lung volume, the most extensively studies have been done on the vital capacity and many formulae which can calculate the normal vital capacity from physical factors as sitting or standing height, weight, BMI, surface area and volume of thorax and combination of these variables, have been developed.[2,6–8,11–13,15,16]

CONCLUSION

There are variations in vital capacity of individuals of same gender in relation with their heights within same ethnic and age groups. Height is the robust factor which affects the lung volumes and capacities among all other physical factors, e.g., gender, age, and ethnicity.

REFERENCES

1. Neil R MacIntyre. The Future of Pulmonary Function Testing. Respiratory Care 2012;57(1):154–61.
2. Muhammad Asif Memon, Muhammad Perwaiz Sandila, Syed Tausif Ahmed. Pulmonary function test in a cohort of older Pakistani population. Pak J Physiol 2006;2(1):34–7.
3. Adesola OO, Adeniran SA, Olubayo-F, Onagbiye S. Relationship between body circumferences and lung function tests among undergraduate students of a Nigerian university. Pak J Physiol 2013;9(1):3–6.
4. Adesola OO, Adeyanju SA, Bamiwuye S. Percent body fat and lung functions among the undergraduate students of Obafemi Awolowo University (OAU). Ile Ife. Nigeria. Int J Biol Sci 2011;3(3):102–10.
5. Sara Khan, Julian L, Yue Chen. Relationship between adiposity and pulmonary function in school-aged Canadian children. Pediatr Allergy Immunol Pulmonol 2014;27(3):126–32.
6. Carey IM, Cook DG, Strachan DP. The effects of adiposity and weight change on forced expiratory volume decline in a longitudinal study of adults. Int J Obes 1999;23:979–85.
7. Aggarwal AN, Dheeraji G, Jindal SK. Applicability of commonly used Caucasian prediction equations for spirometry interpretation in India. Indian J Med Res 2005;122:153–64.

8. Alfrayh A, Khoja T, Alhusai K. FEV_1 and FVC pulmonary function reference values among 6–18-year-old children: a multi-centre study in Saudi Arabia. East Mediterr Health J 2014;20:424–30.
9. Braun L, Wolfgang M, Dickersin K. Defining race/ethnicity and explaining difference in research studies on lung function. Eur Resp J 2013;41(6):1362–70.
10. Quanjer PH. Lung function, race and ethnicity: a conundrum. Eur Respir J 2013;41:1249–51. Erratum in Eur Respir J 2013;42(4):1162.
11. Ayub M, Zaidi SH, Burki NK. Spirometry and flow volume curves in healthy, normal Pakistanis. Br J Dis Chest 1987;81:35–44.
12. Memon MA, Sandila MP, Ahmed ST. Spirometric reference values in healthy, non-smoking, urban Pakistani population. J Pak Med Assoc 2007;57:193–5.
13. Ayub M, Badar A, Daud M, Yousaf M, Khan FA, Waqar A. Pulmonary function tests in Nathiagali natives. J Ayub Med Coll Abbottabad 1998;10(1):24–7.
14. Schwartz JD, Katz SA, Fegley RW, Tockman MS. Sex and race differences in the development of lung function. Am Rev Respir Dis 1988;138:1415–21.
15. Uškin E, Smolej-Naranèiæ N, Schachter EN, Mustajbegoviæ J. Spirometric reference values for nonsmoking boys 9–16 years of age. Acta Med Auxol 1996;28:159–67.
16. Stevens WH, van Hartevelt JH, The PE, Smink HA, Quanjer PH. Validity of ECSC prediction equations for spirometric indices in Dutch conscripts. Eur Respir J 1994;7(1):29–34.
17. Burney P, Hooper R. Lung function, genetics and ethnicity. Eur Respir J 2014;43(2):340–2.

Address for Correspondence:

Dr. Urooj Bhatti, Department of Physiology, Liaquat University of Medical and Health Sciences, Jamshoro, Pakistan.
Cell: +92-333-2671404
Email: uroojbhatti@yahoo.com