The Professional Medical Journal
www.theprofesional.com

DOI: 10.29309/TPMJ/2019.26.11.3173

ORIGINAL PROF-0-3173

PREDICTION OF VITAL CAPACITY THROUGH BMI (BODY MASS INDEX) AND TIDAL VOLUME IN HEALTHY TEENS.

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Article received on:
22/11/2019
Accepted for publication:
25/03/2019

ABSTRACT: Vital Capacity is an essential mirror of a person's respiratory health that can be measured through spirometer. **Objectives:** To analyze the relation of Body Mass Index (BMI) and Tidal Volume (TV) on Vital capacity (VC) in healthy young adults and also to observe any gender differences in this regard. **Study Design:** An analytical cross sectional research. **Setting:** Using convenience sampling on First year MBBS students of Shalamar Medical and Dental College, Lahore. **Period:** From May 2017 to November 2017. **Material and Methods:** Thirty healthy participants with fifteen males and fifteen females, aged 20-22 years were taken in the study after their consent, all were not involved in any endurance training or body-building activity. All of them were the First year MBBS students of Shalamar Medical and Dental College, Lahore. Weight and height of each student was measured via Adult weighing scaleto calculate BMI. Tidal volume and vital capacity were measured through "Power Lab 2005-07, Model 26T" linked to a spirometer pod. Multivariate regression analysis was done by Microsoft excel. **Results:** Linear regression analysis depicted insignificant statistical correlation between VC and BMI in both genders ($p > 0.05$). However, the regression model between VC and TV showed a decrease of 1.14 units in VC with 1 unit increase in TV in male students. **Conclusion:** BMI and TV both negligibly affect the vital capacity in both genders, however Vital capacity is somewhat reduced in healthy males with rise in TV.

Key words: BMI, Power Lab, Vital Capacity, Tidal Volume, Healthy Teens.

Article Citation: Sadiqa A, Saeed N, Pasha HH. Prediction of vital capacity throught BMI (Body mass index) and tidal volume in healthy teens. Professional Med J 2019; 26(11):1904-1910. **DOI:** 10.29309/TPMJ/2019.26.11.3173

INTRODUCTION

The mechanics of respiratory function are determined by an interaction of the lungs, the chest wall andrespiratory muscles. Spirometry has proven itself as an important tool for assessing the respiratory system of patient as well as population.[1] Vital capacity (VC) is a useful measure of body constitution type due to its high association with many anthropometric characteristics. It also provides helpful information about functional capability of respiratory system due to its association with maximum oxygen consumption.[2]

After John Hutchinson published his studies on the use of the spirometer factors affecting the interpretation of respiratory function measurements have been of great interest for the researchers.[3] Obesity is one factor that has been shown to be associated with lower static lung volumes in most of the studies.[4]

Researchers have demonstrated two-third reduction in values of lung compliance in obese people as compared to non-obese.[5] They are also in a state of subclinical inflammatory insult due to increase in number of adipose tissue in the body which leads to increase release of inflammatory markers and cytokines resulting in bronchial hyperactivity.[6]

Obese people tend to have a rapid and shallow breathing pattern similar to patients of neuromuscular disorders and chest wall deformity this leads to higher respiratory rate but reduction in tidal volume (TV).[7] Dynamic lung volumes like VC are often normal but in a retrospective study, they have found a 75% decrease in vital capacity in morbidly obese person.[8]

Pakistan is a developing country facing the double burden of communicable and non-communicable disorders. Obesity has emerged as a public threat in recent years in Pakistani adolescents due to urbanization and rapid industrialization.[9] Prevalence of obesity is higher among adolescent females as compared to males.[10] Therefore it is crucial to understand the relation between Body mass index (BMI) of Pakistani healthy adolescents with the measurements of tidal volume and vital capacity.

METHODOLOGY

Subjects

An analytical cross sectional research was conducted, using convenience sampling on First year MBBS students of Shalamar Medical and Dental College, Lahore. A total thirty students with fifteen girls and fifteen boys, as participants were consented for this study, aged 20–22 years, in May 2017 to November 2017. Only healthy students with no present illness were included, also students involved in any exercise training or body building were excluded from the study.

Equipment and Protocol

Firstly spirometer pod was linked to "Power Lab 2005-07, Model 26T", through Input 1. Spirometer pod was also attached to pneumotachometer with its two plastic pipes as presented in Figure-1. Bore tubing, filter and mouthpiece all were pre-assembled to the flow head of pneumotachometer, as appreciated in Figure-2. Then Lab Tutor software was clicked and its related application for the measurement of Lung Functions "Respiratory Airflow & Volume" was selected. A calibration window was seen on the screen of Power Lab Data Acquisition Unit, instructions were followed to go through the procedure in order to get measurements of Vital Capacity and Tidal Volume in Liters. Accordingly the digital graphs were plotted on the calibration window for each subject, which were labelled for identification purposes as seen in Figure-3. Tidal volume was obtained through normal breath of each individual via mouth (nose was clipped to hinder the air passage through nose) and Vital Capacity was calculated after a subject breathed with maximum inhalation and maximum exhalation. BMI values were taken in kg/cm via "Adult weighing scale ZT-160", where each participant was weighted along with his/her shoes.

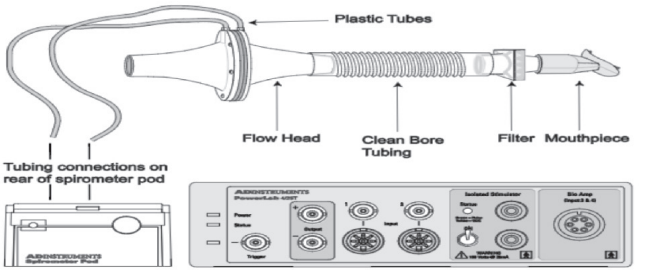

Figure-1. Pneumotachometer in powerLab assembly

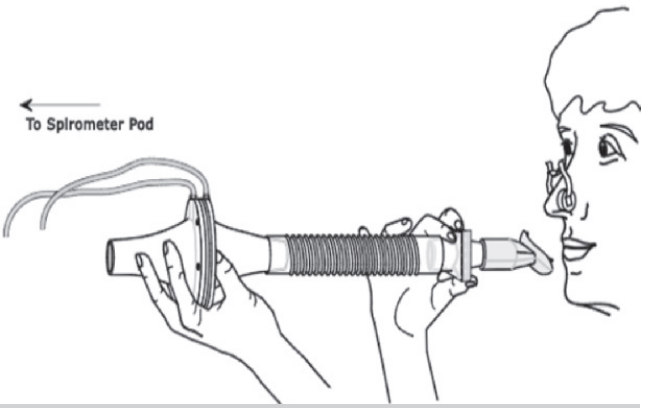

Figure-2. Holding positioning of pneumotachometer

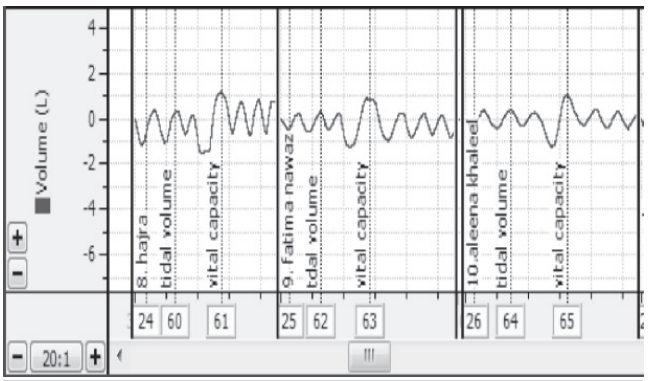

Figure-3. Labelled digital spirogram on clibration window

Statistics

Micorsoft Excel was used to get linear regression analysis, with scatter plots. Values of Vital Capacities were plotted on y-axis as dependent variables, while BMI and Tidal volumes were taken on x-axis as independent variables, separately for three categories in each regression Model; girls, boys and both genders. Alpha was taken as 0.05

and for each plot obtained p-value for x-variable, was finally considered to announce statistical significance of the correlation.

RESULTS

The average values of recorded BMI. Lung Tidal or Volume and Lung vidal capacity of each studied group have been mentioned alongwith its standard error of Mean in Table-I. Linear Regression analysis displayed insignificant statistical correlation between Lung Vital Capacity (L) and BMI (kg/cm) in young healthy boys, girls separately and both genders inclusively (Table-II). Predicted value for Vital Capacity in all studied groups i.e. boys, girls and both genders falls only 0.043 (Figure-4), 0.85 (Figure-5), and 0.01(Figure-6), unitsrespectively, with one unit increase in BMI of all related three groups. So negligible decrease of <0.09 unit in Vital Capacity is recorded in each category, with 1 unit increase in BMI.

The regression model between Vital Capacity in relation to Tidal Volume (L), in all three studies groups also resulted with insignificant results (Table-II). However the statistics concluded that in boys separately the regression model showed a decrease of 1.14 units in predicted value of Vital Capacity by one unit rise in their respective Tidal Volume (Figure-7). Though a relatively least effect is observed in girls; here only 0.074 unit reduction in vital Capacity is reflected with one unit increase in value of Tidal volume in girls (Figure-8). Similarly when results are computed for all boys and girls, it is noticed that with one unit increase in Tidal Volume 0.52 unit decrease can be predicted in Vital Capacity of all boys and girls (Figure-9).

Groups	BMI (kg/cm) Mean ± SEM	Tidal Volume(L) Mean ± SEM	Vital Capacity (L) Mean ± SEM
All Boys	25.87 ± 1.78	0.42±0.07	3.17±0.33
All Girls	24.15 ± 0.64	0.36 ± 0.06	2.46±0.136
All Boys and Girls	24.97 ± 0.92	0.39±0.047	2.8±0.18

Table-I. Mean values along with standard error of mean of each group

Analyzed Variables	Each Studied Class	P - Values	Forecasted Results
Vital Capacity (dependent variable) and BMI (independent variable)	All Boys	0.45	1 unit rise in BMI, would fall predicted Vital Capacity by 0.043 units in all Boys* (Figure-1).
	All Girls	0.17	1 unit rise in BMI, would fall predicted Vital Capacity by 0.085 units in all Girls* (Figure-2).
	All Boys & Girls	0.81	1 unit rise in BMI, would fall predicted Vital Capacity by 0.01 units in all boys and girls* (Figure-3).
Vital Capacity (dependent variable) and Tidal Volume (independent variable)	All Boys	0.4	1 unit rise in Tidal Volume, would reduce predicted Vital Capacity by 1.14 units in all Boys* (Figure-4).
	All Girls	0.91	1 unit rise in Tidal Volume, would reduceVital Capacity by 0.074 units in all Girls* (Figure-5).
	All Boys & Girls	0.52	1 unit rise in Tidal Volume, would reduce predicted Vital Capacity by 0.52 units in all boys and girls* (Figure-6).
*However as p > 0.05, thus relation is proved statistically significant			

Table-II. Regression analysis of studied groups, along with their p-values and inferred predictions

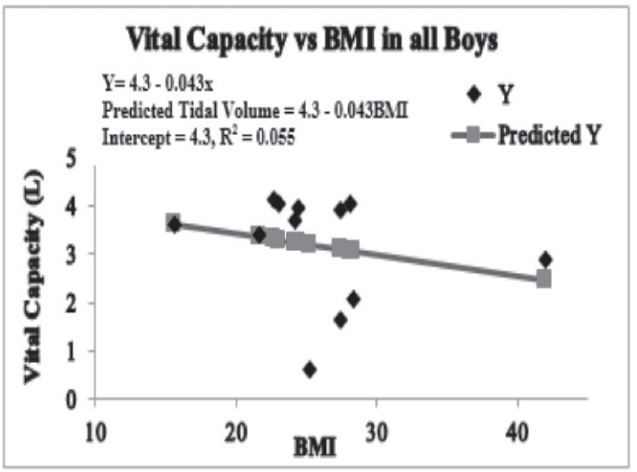

Figure-4. 1 Line fit plot presenting regression relation between vital capacity as dependent variable and BMI as independent variable, in all boys (P=0.45).

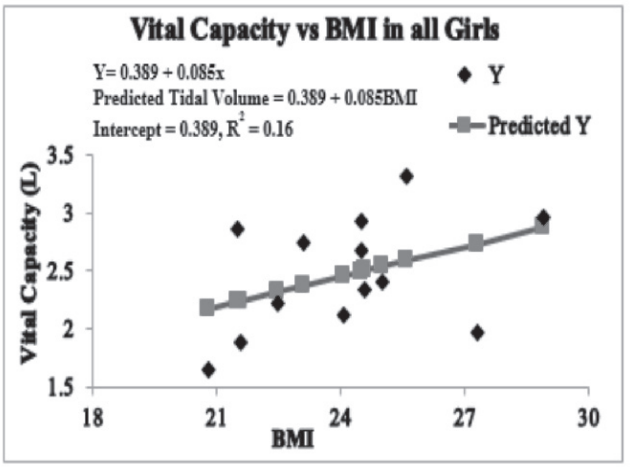

Figure-5. 1 Line fit plot presenting regression relation between vital capacity as dependent variable and BMI as independent variable, in all girls (P=0.17).

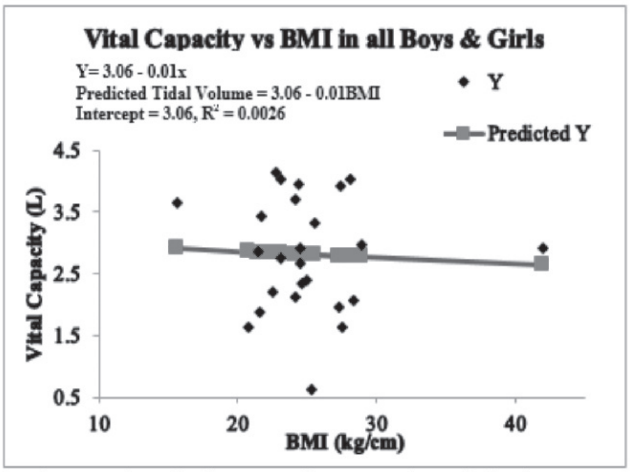

Figure-6. 1 Line fit plot presenting regression relation between vital capacity as dependent variable and BMI as independent Variable, in all boys and girls (P=0.81).

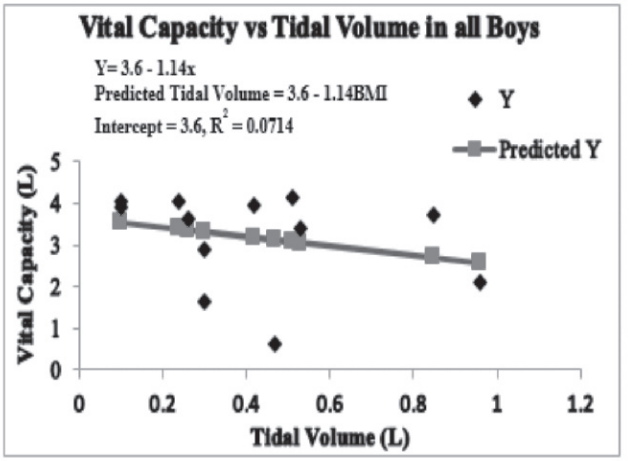

Figure-7. 1 Line fit plot presenting regression relation between vital capacity as dependent variable and tidal volume as independent variable, in all boys (P=0.4).

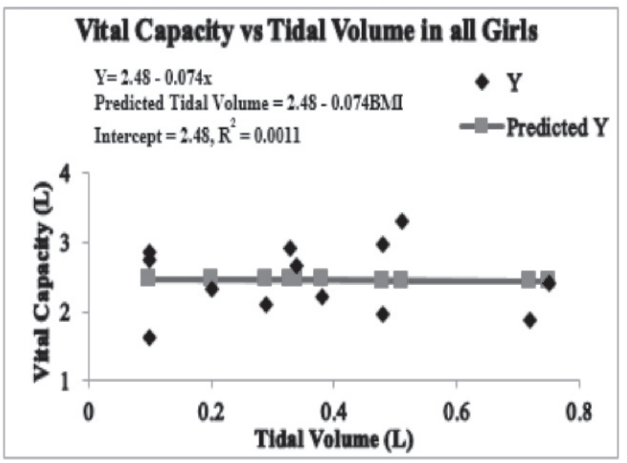

Figure-8. 1 Line fit plot presenting regression relation between vital capacity as dependent variable and tidal volume as independent variable, in all girls (P=0.9).

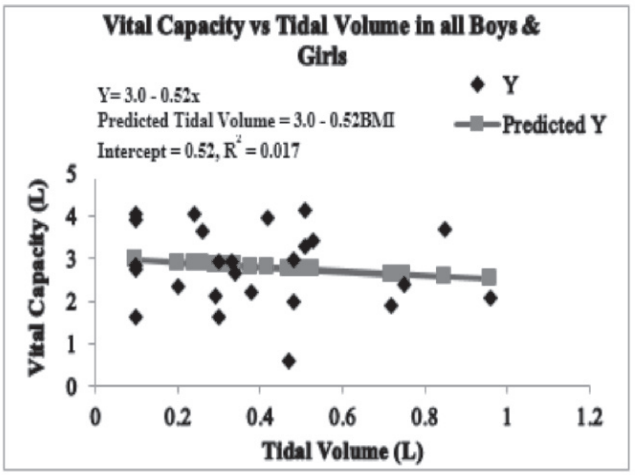

Figure-9. 1 Line fit plot presenting regression relation between vital capacity as dependent variable and tidal volume as independent variable, in all boys and girls (P=0.52).

DISCUSSION

Breathing is a sign of life. It plays a vital role in determination of lung function. To uphold respiratory homeostasis, the contents that are under the respiratory system must necessitate stability in their work. The efficient and easiest method to estimate lung function is by determining Vital capacity as it offers information crucial for the characterization of the pathophysiological state of lungs.[11] Many studies have proved that various factors like weight[12], height,[13] bone mineral density[14], BMI[15], hypertension[16] and diabetes[17]can affect the vital capacity. However, to our best knowledge no study have been done in Pakistan to find out the relevant association of tidal volume and BMI with Vital capacity especially in college students.

Our results depicted that there was no significant correlation between BMI and vital capacity, and also between tidal volume and vital capacity in healthy college students. Our results are in line with a study conducted in Zhuang National University, China where they evaluated the relationship between BMI and vital capacity in college students and found no significant association between the two variables. They explained these findings are due to the study population as they have chosen college students that are healthy individuals with minimal influence of respiratorydiseases.[18]

Griendt el al., demonstrated improvement in values of FEV1, FVC and TLC after reduction in body weight. Similarly, in a study conducted by Littelon in 2013, found reduction in all lung volumes and capacities with increase in values of BMI. The results of these studies are in contrast with ours. This can be explained by the fact that the fat is lost from the areas which negatively affects respiratory functions.[19]

However, after regression analysis, we found that decrease in vital capacity can be predicted with rise in tidal volume in male students whereas no association was found in eutrophic females. Faria et al., have demonstrated similar results. They explained this is because of the difference in muscularity and adiposity of both genders.[20] As increase in BMI in male gender is mostly due the effect of muscularity which positively affects vital capacity. In female increase in BMI is mostly due to the effect of adiposity which negatively effects all pulmonary functions. It has been shown that the fat distribution pattern is more representative when compared only to the BMI.[21]

BMI can affect vital capacity by several mechanisms that may be mechanical or inflammatory.[18] Descent of the diaphragm is impeded by accumulation of intraperitoneal fat.[16] Moreover, increase in abdominal fat reduces the expiratory reserve volume by displacing diaphragm upwards.[21] Deposition of fat in the thoracic region negatively affects the expansion of rib cage.[22] Many researchers have also pointed out the role of increase in inflammatory markers like C- reactive protein, leptin, TNF, IL-1β and IL-6 in obese persons that exerts local effect in pulmonary tissue leading to decrease in airway diameter.[23]

Present study, contrary to the studies discussed above, we are unable to point out an obvious relation between BMI and VC. This may be due to the fact that our studied group was healthythus eliminating the influence of disease. Moreover, it may be due to the racial difference as it is the first study to be conducted upon college students in Pakistan. In contrast, our research also suggests that the mechanisms put forward by former scholars may not apply to college students, and new research mechanisms need to be explored for college students.

CONCLUSION

BMI (kg/cm) and Tidal Volume (L) both negligibly effect the Vital Capacity (L) in healthy young adults i.e. with increase in BMI, decrease in Vital Capacity is observed, and similarly with rise in Tidal Volume a decent in Vital Capacity is detected in all studied groups of healthy young adults. Though all relations not proved statistically significant.

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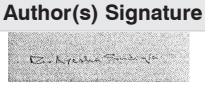
AUTHORSHIP AND CONTRIBUTION DECLARATION

Sr. #	Author(s) Full Name	Contribution to the paper	Author(s) Signature
1	Ayesha Sadiqa	Concept, Synthesis and planning of the research, active participation in data collection and analysis.	
2	Nabiha Saeed	Introduction, literature review and discussion.	
3	Hafiza Hina Pasha	Literature search, Discussion and references.