ORIGINAL ARTICLE

Correlation of BMI Variation with Tidal Function in Healthy Young Adults

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ABSTRACT

Objective: To observe the effect of Body Mass Index (BMI) on Tidal volume and its rate of air flow in healthy young adults.

Study Design: Cross-sectional study

Place and Duration of Study: Department of Physiology at Shalamar Medical and Dental College, Lahore, from 14th April to 20th August 2018.

Materials and Methods: Thirty students with fifteen boys and fifteen girls were involved in the study. Convenience sampling technique was used for First year Medical Undergraduate students, aged 19–21 years; also consent was taken each participant. All the subjects were healthy and not on any medication or involved in endurance training program. Power Lab with spirometer pod and pneumotacho meter was used to measure Tidal volume and its air flow rate. Data was collected through application namely "Respiratory Airflow & Volume" in Lab Tutor software. BMI values were taken in kg/cm via "Adult weighing scale". Linear regression analysis was performed to see the effect of BMI on tidal volume and its rate of air flow.

Results: In both genders BMI was not proved a predictor of Tidal volume (L) nor it was proved a predictor of Tidal air flow rate (L/min) in healthy young adults resulted through regression analysis. Where Tidal volume and its rate of flow were taken as dependent variables and BMI was considered as independent variable, however the results proved statistically insignificant p-value (>0.05).

Conclusion: BMI has no correlation with Tidal volume and its air flow rate in healthy young adults.

Key Words: *Tidal Volume, Young Adults, Tidal Function, BMI Variation.*

Introduction

Spirometry is meant for the measurement of lung volumes and capacities in order to examine the efficiency of lungs.[1] Lung volumes are further divided into: dynamic and static physiological classes; where static lung volumes are again classified into: tidal, inspiratory reserve, expiratory reserve, and residual volume.[2]

Tidal volume is defined as the amount of air, transported into and out of the lungs with each respiratory breath, which is significant for natural respiratory cycle. Its value in a healthy adult male and female is approximately 500 and 400 mL respectively, but can also be transformed according to the variation in physiological needs.[1]

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Many factors influence tidal volume; obesity is one of those, on which time to time many studies do their best in order to observe the relation of obesity with the pulmonary functions. The association of obesity with reduced pulmonary performance has received considerable attention.[3] So role of BMI cannot be neglected while assessing the lung function tests. Also a study confirmed that even shape and position of the diaphragm is related with the rate of tidal air flow in humans, especially in those having airflow limitation. In the same study it is also claimed that in obese individuals, the tidal volume is declined due to relative increase in dead space. Obesity is defined in terms of body mass index (BMI), which is calculated by dividing weight on height square of the subject, where weight is measured in kilograms and height in meters. World Health Organization (WHO) has declared a BMI of 25 - 29.9 kg/m^2 as overweight and BMI of ≥ 30 kg/m^2 as obese.[4] On the other side numerous cross-sectional researches found improved lung functions due to decrease in BMI, especially in asthmatic patients.[5,6] The effects of obesity (high BMI) on lung volumes have been explained in literature.[7] But there is found paucity on the effect of BMI (physiological variations) in healthy individuals with respect to respiratory tidal function of lungs. The aim of the present study was to observe the effect of Body Mass Index (BMI) on Tidal volume and its rate of air flow in healthy young adults.

Materials and Methods

Present cross sectional study has been performed on First year Medical Undergraduate students, aged 19–21 years, at Shalamar Medical and Dental College, Lahore, in May 2017. A total of 30 students have been involved with 15 boys and 15 girls by using convenience sampling technique. The study was approved by Ethical Review Board of the Institute. All the participants involved in this research were consented in writing on the written consent forms, before the initiation of this research project. Also all the participants were ensured regarding their personal biological data in connection to their individual privacy concerns. All the students who were physically healthy and without any medication or with present illness were included in the study and those who were involved in any physical training program or on medication were excluded from the study. The data was collected by a professional medical physiologist with the help of a laboratory technician in Physiology Research Laboratory of the department of Physiology. The data type was parametric.

On one side, spirometer pod was connected to “Power Lab 2005-07, Model 26T”, within in its Input 1 and on the other side spirometer pod was also connected to pneumotachometer Fig. 1, with its two plastic tubes. Clean bore tubing, filter and mouthpiece was also attached to the flow head of pneumotachometer as shown in Fig. 2. Software Lab Tutor was opened with its related application “Respiratory Airflow & Volume” and a calibration window was appeared on the screen of Laptop linked to Power Lab Data Acquisition Unit. Following the given instructions in the application, each subject was connected to the spirometer as shown in the Fig. 3. The guidelines were given to each subject to take three normal breathes via mouth (to make this sure, a nose clip was also used to avoid air passage through nose). Tidal Volume of each candidate was represented in a digital graph on the calibration window as shown in the Fig. 4. Values were directly obtained through Spiro metric analysis on Power Lab. Tidal Volumes was measured in Liters and Rates of Tidal Air Flow were measured in Liters per minute. Height in centimeters and weight in kilograms (along with wore shoes) were recorded through “Adult Weighing Scale ZT-160” and BMI calculations were taken finally in kg/cm.

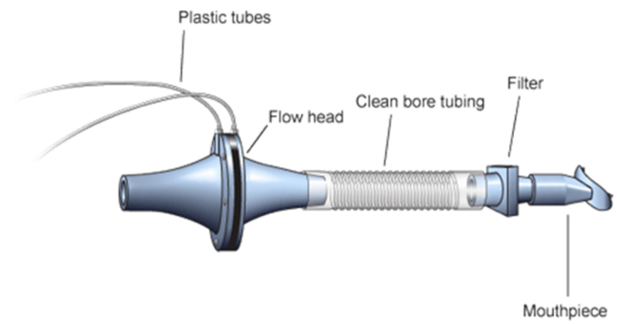

Fig 1: Pneumotachometer of Power Lab

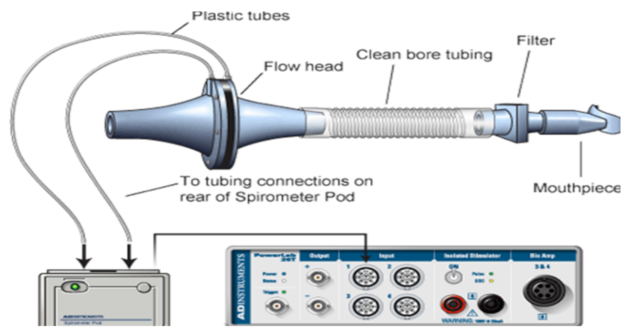

Fig 2: Spirometer Equipment Setup for Power Lab

Fig 3: Subject Positioning with Pneumotacho Meter

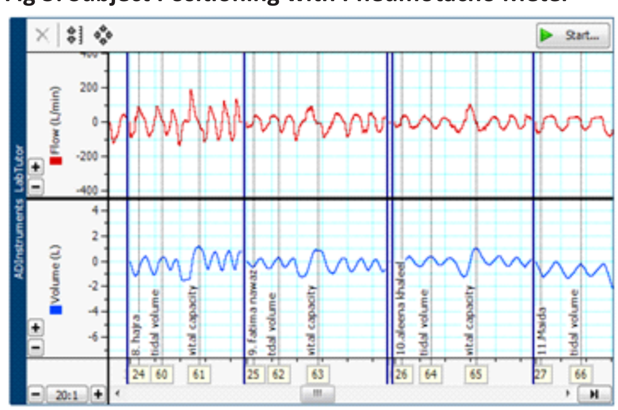

Fig 4: Digital Graph showing Spirogram on Clibration Window

Data was tabulated on Microsoft Excel and linear regression models were used along with one line fit graphs with BMI was taken as independent variable, while Tidal Volume/Air Flow rate were taken as dependent variable for all categories. Alpha was considered as 0.05 and statistical significance was interpreted accordingly on the basis of obtained p-value of x-variable in each linear regression pattern.

Results

Regression study of linear pattern is showed a non-significant correlation between values of Tidal Volume (total boys and girls in the study) as dependent variable and BMI of the same sample group as independent predictor of expected Tidal volume by any change in BMI (Table II). With 1 unit change in BMI only 0.03 unit changes in predicted Tidal volume of both genders (Fig. 5). Similar negligible change is detected when same regression variables are plotted for boys (Fig. 6) and girls (Fig. 7) separately. Henceforth BMI is not correlated with Tidal Volume in healthy young adults.

Linear regression analysis is indicated a non-significant association between values of Rate of Air Flow in Tidal Volume (both boys and girls) as dependent variable, and BMI of the same sample group as independent predictor of expected Tidal Air Flow with any change in BMI (Table I). A decrease of 0.67 units in predicted value of Tidal Air Flow in both genders is observed, with 1 unit increase in their respective values of BMI (Fig. 8). While a decrease of 1.11 unit in Tidal Air Flow is noticed with 1 unit increase in BMI, when regression plot is taken only for the boys (Fig. 9). Though a direct non-significant correlation is perceived when same regression variables are plotted only for the girls i.e. an increase of 0.23 unit in rate of Tidal Air Flow, is displayed with 1 unit rise in their BMI (Fig. 10). Therefore BMI is only a minor predictor for Rate of Tidal Air Flow in young adults, as with its rise Tidal Air Flow is slightly decrease in the boys and in both genders collectively, while with increase in BMI increase is observed in tidal Air Flow in the girls.

Table I: Averages of each Studied Group with Standard Error of Mean (SEM)

Sr. No.	Groups	BMI (kg/cm)	Tidal Volume (L)	Tidal Air Flow Rate (L/min)
		Mean ± SEM	Mean ± SEM	Mean ± SEM
1	All Males	25.87± 1.78	0.42 ± 0.07	33.89 ± 5.53
2	All Females	24.15 ± 0.64	0.36 ± 0.06	22.92 ± 5.079
3	All Males and Females	24.97 ± 0.92	0.39 ± 0.047	28.18 ± 3.83

Table II: Regression Sets of Each Line Fit Plot, along with Their P – Values and Deduced Effects

Sr. No.	Regression Groups: Y-Axis Variables	Regression Groups: X-axis Variables	Interpreted Results	P - Values
1	Tidal Volume of both males and females	BMI of both males and females	With 1 unit increase in BMI, the predicted value of Tidal Volume would increase by 0.003 units in both genders* (Fig.5).	0.78
2	Tidal Volume of the males subjects	BMI of the males subjects	With 1 unit increase in BMI, the predicted value of Tidal Volume would decrease by 0.003 units in the males* (Fig. 6).	0.82
3	Tidal Volume of the females subjects	BMI of the females subjects	With 1 unit increase in BMI, the predicted value of Tidal Volume would increase by 0.035 units in the females* (Fig. 7).	0.20
4	Tidal Air Flow of both males and females	BMI of both males and females	With 1 unit increase in BMI, the predicted value of Air Flow would decrease by 0.67 units in both genders* (Fig. 8).	0.44
5	Tidal Air Flow of the males subjects	BMI of the males subjects	With 1 unit increase in BMI, the predicted value of Air Flow would decrease by 1.11 units in the males* (Fig. 9).	0.25
6	Tidal Air Flow of the males subjects	BMI of the males subjects	With 1 unit increase in BMI, the predicted value of Air Flow would increase by 0.23 units in the females* (Fig. 10).	0.25

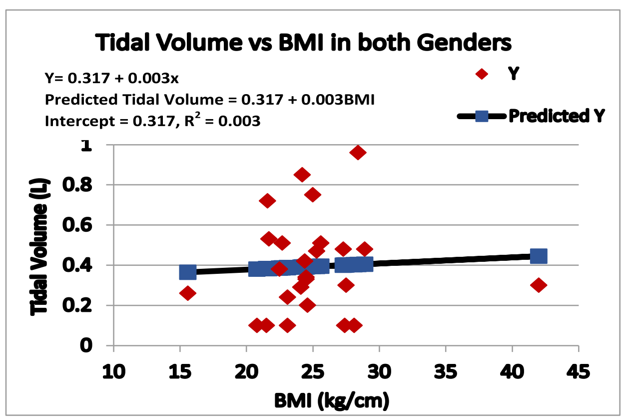

Fig 5: Scatter Diagram Showing Linear Regression Plot Between Tidal Volume As Dependent Variable And BMI As Independent Variable, In Both Genders (P=0.78).

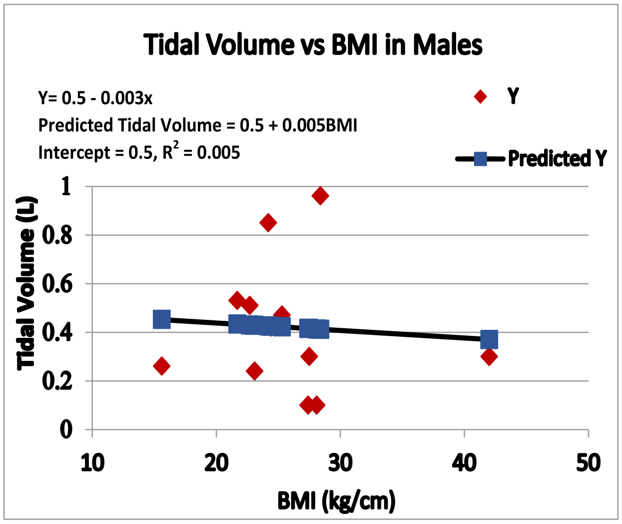

Fig 6: Scatter Diagram Showing Linear Regression Plot between Tidal Volume as Dependent Variable and BMI as Independent Variable, in Males (P=0.82).

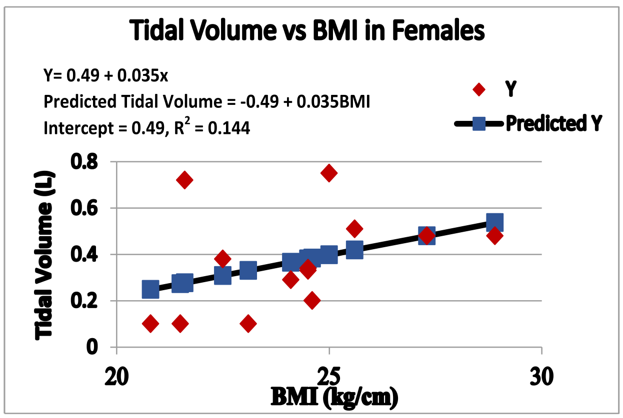

Fig 7: Scatter Diagram Showing Linear Regression Plot Between Tidal Volume as Dependent Variable and BMI as Independent Variable, in Females (P=0.20).

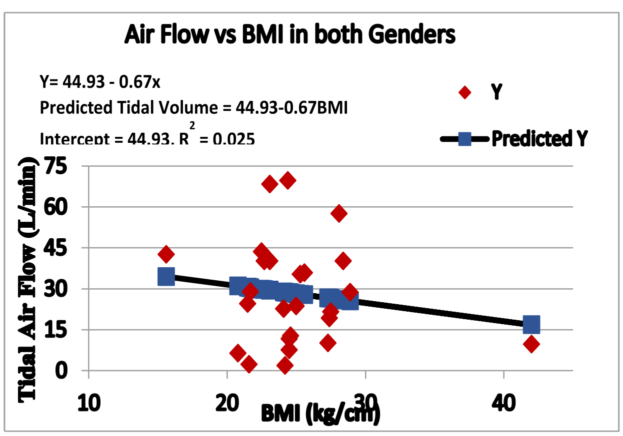

Fig 8: Scatter Diagram Showing Linear Regression Plot between Air Flow as Dependent Variable and BMI as Independent Variable, in both the Genders (P=0.44).

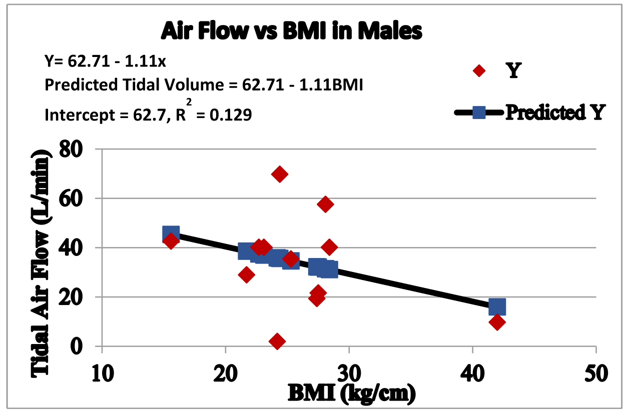

Fig. 9: Scatter Diagram Showing Linear Regression Plot between Air Flow as Dependent Variable and BMI as Independent Variable, in Males (P=0.25).

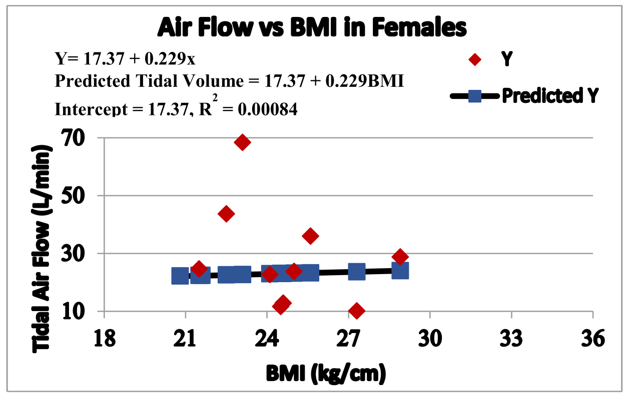

Fig. 10: Scatter Diagram Showing Linear Regression Plot between Air Flow as Dependent Variable and BMI as Independent Variable, in Females (P=0.93).

Discussion

The present study exhibited no significant relation of BMI with tidal volume and tidal air flow rate in both male and female young adults. As minor variations in the BMI within normal physiological range are not the main influencers of usual pulmonary functions. Although previous standard morphometric procedures confirm that males have larger lung size, more bronchioles and wider diameter of airway passages compare to females of same age and stature. These anatomical differences between male and female are the real basis of variations in static lung volumes and capacities in both genders.[8] To explore the effect of BMI on prime lung functions i.e. Tidal functions are the main purpose of our study as static lung volumes and capacities can be forecasted on several physiological basis like gender, age, weight, height and even ethnicity of that population.[6]

Other influencing factors on lung volumes and capacities are physical activity (like exercise and endurance training), high altitude and most significantly the position of the individual; all must be in consideration while doing spirometry. However alongside, the quality and accuracy of the apparatus in use and its technique for estimation of the lung volumes/capacities is also a considerable factor. On high altitude, lung volumes usually decline because of increased pulmonary blood flow, edema and obliteration of premature narrow airways. Although these alterations resolve after returning back to sea level. Postural changes also affect tidal volume, as in sitting or supine position, the effect of gravity on abdominal cavity is quite less in comparison to standing posture.[8] In our study all the subjects are in sitting posture that eliminates the effect of posture among the subjects.

It is also evident that the height of the diaphragm has an inverse relation with subject's age, meaning size of the chest is also one of the major determinants in lung function tests.[6] Tall stature is classically associated with increased static lung volumes/ capacities, while increased body weight is linked with lesser lung volumes especially in obese people. In the same context Lutfi *et al.,* explained the role of ethnicity in this regard as it is also considered one of the prime contributor to lung functions, e.g. European white Americans descent have longer chest/leg ratio, and subsequently have more values for lung volumes, compared to African black American's ancestors. That's why Global Lung Initiative (GLI) announces spirometric predicted calculations with careful ethnic variations, which can be used as a universal standard across the World.[8] In our scenario ethnicity also is a non-variable factor in terms of BMI association with Tidal lung function.

Obesity is also regarded as a negative factor in relation to physiological lung volumes. Many studies represent the association of restrictive respiratory pattern obese individuals and not with healthy individuals[9] similar to our findings. Obesity has numerous effects on pulmonary efficiency, such as in obese persons ventilation has to be raised in order to compensate the depressed tidal volumes in them.[10] Total compliance of whole respiratory system is reduced in massively obese individuals, but here the distribution of fat account more as compared to increased BMI.[7] Even previous studies also prove normal spirometric measurements in mildly obese individuals. More than that latest researches conclude that even in massively obese individuals, the restrictive pulmonary effects are found modest. Only with very high BMI increases i.e. morbidly obese persons, a reduction in expiratory flow, FEV_1 and forced vital capacity (FVC) has been observed.[4,12] Another study also exhibits high tidal volume in obese women.[10] Whereas restrictive lung diseases have an association with reduced pulmonary compliance that interfere with lung expansion and resultantly diminishes static lung volumes/ capacities.[3,14]

National Institutes of Health declares subsequent scheme of BMI grading: underweight <18.5; normal 18.5 – 25; overweight 25 - 30; obese 30 - 40; severely obese ≥40, all values are taken in kg/m^2.[11,15] Studies based on four categories male and female college students' i.e. Underweight, normal BMI, overweight and obese, also shows no significant difference in all groups with respect to their vital capacities.[3,13] Other studies also observe no significant gender based difference between BMI and vital capacity as lung function.[16,17] So our results are very much consistent with this previous study; there is no evidence that BMI changes in healthy young adults have an association with tidal lung function and thus BMI cannot predict the variations in tidal volume and its air flow rate in healthy young adults without gender discrimination.

The present study has small sample size; with larger sample size the results would be more significant. Moreover the study comprised only young adults, so results only reflect the respective age group.

In future a study with large sample size, varied ethnicity and wide range of age can explore the BMI correlation with Tidal function in a more elaborated way.

Conclusion

BMI variation has no correlation with Tidal Volume and tidal air flow rate in healthy young adults including both males and females.

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