

A Cross-Sectional Study on the Correlation between Anthropometric Parameters and Pulmonary Function Testing in Asymptomatic Healthy Young Adults

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ABSTRACT

Purpose: The aim of this study was to examine the correlation between anthropometric parameters and pulmonary function testing in asymptomatic healthy young adults.

Methods: A total of 219 asymptomatic and healthy participants, ranging in age from 17 to 27 years, were enrolled in the study. Height was measured with a stadiometer. Weight was recorded using a weighing machine. Waist circumference (WC), hip circumference (HC), and waist-to-hip ratio (WHR) were determined with the help of an inch tape. Body mass index (BMI) and body surface area (BSA) were calculated according to standard formulae. Pulmonary function testing was conducted with spirometry. Physical activity was documented with the International physical activity questionnaire (IPAQ).

Results: There exists a statistically significant positive correlation between height and forced vital capacity (FVC) ($r = 0.73$, $p < 0.05$), as well as forced expiratory volume in one second (FEV_1) ($r = 0.73$, $p < 0.05$). Similarly, body surface area (BSA) demonstrated a significant positive correlation with FEV_1 ($r = 0.64$, $p < 0.05$) and FVC ($r = 0.59$, $p < 0.05$).

Conclusion: The findings infer that among all anthropometric measures, height, weight and body surface area are significantly correlated with pulmonary function parameters in asymptomatic healthy young adults, highlighting their relevance in interpreting PFT outcomes.

Keywords: Body mass index. Physical fitness. Waist circumference. Waist to hip ratio. Spirometry.

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INTRODUCTION

Abbreviations

WC – Waist circumference

HC – Hip circumference

BSA – Body surface area

WHR – Waist to hip ratio

BMI – Body mass index

IPAQ – International physical activity questionnaire

FEV1 – Forced expiratory volume in 1 second

FVC – Forced vital capacity

SD - Standard Deviation

INTRODUCTION

Anthropometric measurements help in determining the nutrition status and body composition of an individual⁽¹⁾. Body composition is associated with pulmonary function^(2, 3). The body composition is negatively affected due to increasing pollution and other environmental factors⁽⁴⁾. The respiratory system of the people living in highly polluted metro cities is severely affected by the air pollution^(5, 6). Physical activity is affected by environment-related factors and body composition⁽⁷⁾. This results in decreased physical activity levels and body composition. Pulmonary function testing is conducted to diagnose any airway disease^(8, 9). A significant relationship between pulmonary function and cardiovascular mortality has been observed⁽¹⁰⁾. The updated guidelines categorize obesity into two stages for Asian Indians⁽¹¹⁾. Abdominal

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obesity as well as excess body fat are common among Indians⁽¹²⁾. Additionally, it is proposed that pulmonary function is affected by obesity⁽¹³⁻¹⁷⁾. A negative correlation was observed between adipose tissue distribution and the measures of lung ventilation^(18,19).

The waist to hip ratio (WHR) is a measure of central adiposity and is negatively associated with pulmonary function test interpretation^(20, 21). Waist circumference (WC) is determined to play a significant role in predicting the pulmonary function⁽²²⁾. For males and females, adverse waist circumference values were defined as more than 90 cm and 80 cm, respectively⁽²³⁾. Increased values of WHR, hip circumference (HC), and WC are linked to higher death risks from diabetes-related and overall causes⁽²⁴⁾.

A deficiency of pertinent information exists concerning the importance of anthropometric parameters in determining pulmonary function in relevance to the Indian population. Hence, the objective of this research is to investigate whether there exists any association between lung function and anthropometric parameters.

METHODS

The study was registered under the Central Trial Registry of India (CTRI) with registration number REF/2024/08/090640. The investigation adhered to the guidelines outlined in the Declaration of Helsinki and obtained approval from the Institutional Ethical Committee of Delhi Pharmaceutical Sciences and Research University. A notice was placed on the notice boards of various universities of Delhi-NCR after taking appropriate permissions, explaining the purpose of this study, describing the procedure to be followed, and briefing the possible benefits that one might personally derive after participating in such a study. The participants were provided with the explanation of the methodology, and those who consented were asked to sign an informed consent. The participants who satisfied the inclusion criteria were enrolled based on convenient sampling. Inclusion criteria comprised subjects of any gender with age ranging from 17 to 27 years. Subjects with a history of smoking were excluded. Subjects diagnosed with any musculoskeletal, neurological, and psychological illness that could affect the outcome of the study were excluded.

PULMONARY FUNCTION TESTING

PFT guidelines by American Thoracic Society were followed while conducting and interpreting the pulmonary function test⁽²⁵⁾. During procedure, the subjects wore a nose clip, and a firm contact with the mouth was made using a mouth-piece. As the nose was sealed, subject had to inhale and exhale using the mouthpiece only. The test was explained beforehand to the subject. The participants were requested to take a deep breath, exhale forcefully, and maintain it for at least six seconds. Parameters like FEV1 (in L), FVC (in L), Forced Expiratory Volume in one second (FEV1), their ratio, and Force Vital capacity (FVC) were recorded during the pulmonary function test. The best reading was taken into consideration for

assessment after three acceptable attempts. The process was repeated and readings were recorded using a spirometer (Spirobank G, Smiths Medical PM, Wisconsin, USA). Only those subjects whose pulmonary function test results were found to be within normal limits were included in the study.

ANTHROPOMETRIC MEASUREMENTS

After the screening process, a total of 219 subjects were included for additional testing. A stadiometer was used to measure the height of the subjects (SECA 213 range with 1 mm graduation). Weight was recorded using a weighing machine (Healthgenie, India) that was calibrated every month as per the instructions given in the manual. Then, WHR, HC and WC along with other health-related parameters were measured. The Mosteller formula was employed in the calculation of the BSA. The formula is, $BSA = \sqrt{h(cm) \times w(kg)} \div \sqrt{3600}$. The formulae used to calculate the BMI and WHR were $\text{weight}(kg)/(\text{height}(m))^2$ and ratio of WC and HC respectively. Demographic data and medical history were documented via interviews, while the physical activity levels were recorded using International physical activity questionnaire (IPAQ) among the subjects.

STATISTICAL ANALYSIS

The data analysis and interpretation in this study were conducted using IBM SPSS Statistics software package, version 26.0 (IBM Corp.). The mean and SD were utilized to represent the data. A two-tailed Pearson correlation was calculated. The statistical significance of the results was determined in instances where the p-value was lower than 0.05. Correlation between anthropometric measurements and PFT measures was explored.

RESULTS

Data was collected in 219 subjects using a convenient sampling method. The data was collected in asymptomatic healthy young adults, and their ages range from 17 to 27 years. The anthropometric variables of the subjects are detailed in table I. The average age of the participants was found to be 20.93 years, with a SD of 1.90. The height of the subjects has a wide variability from 147 cm to 182 cm, with a mean and SD of 164.26 cm and 9.15, respectively. The weight of the subjects ranged from 38 kg to 113 kg, with a mean weight of 58.61 kg and a standard deviation of 10.62. The Body Mass Index (BMI) ranged from 15.24 to 34.11, with most subjects falling within the normal range (n=168, 76.71%). The sex ratio was evenly distributed, with females making up 56.62% of the sample size. Height was also highly correlated with FEV1 and FVC, with correlation coefficients of 0.73 each. The graphs of correlations are represented in figure I to IV

In terms of WC, the normal acceptable limits are 80 cm for women and 90 cm for men. The overall mean and SD of WC was 75.80, while it was 79.24 ± 8.87 in males and 73.17 ± 9.11 in females in the present study. The mean and SD of WHR was 0.84 ± 0.05 overall, with values of 0.85 ± 0.04 in males and 0.82 ± 0.04 in females.

The correlation of various anthropometric parameters with pulmonary function measures are listed in table III. There was a positive correlation between BSA and FEV1 and FVC, with correlation coefficients of 0.60 and 0.64, respectively.

The table II shows the mean and SD for FEV1, FEV1/FVC and FVC pulmonary function metrics, with FEV1 having a mean of 2.96 and SD of 0.64, and FVC having a mean of 3.40 and SD of 0.79. The ratio of FEV1/FVC had a mean value of 87.62% and a standard deviation of 6.07.

Table (I) Characteristics of the subjects

S no.	Variable	Overall (N=219)		Male (n=95)		Female (124)	
		Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
1	Age	20.93	1.90	20.77	1.61	21.05	2.09
2	Height	164.26	9.15	171.07	7.75	159.05	6.27
3	Weight	58.61	10.63	64.51	10.23	54.09	8.53
4	BMI	22.38	2.99	22.78	2.87	22.08	3.06
5	BSA	1.65	0.19	1.79	0.17	1.55	0.14
6	WC	75.80	9.48	79.24	8.87	73.17	9.11
7	HC	90.53	8.93	93.23	8.80	88.46	8.50
8	WHR	.84	0.04	0.85	0.04	0.83	0.05

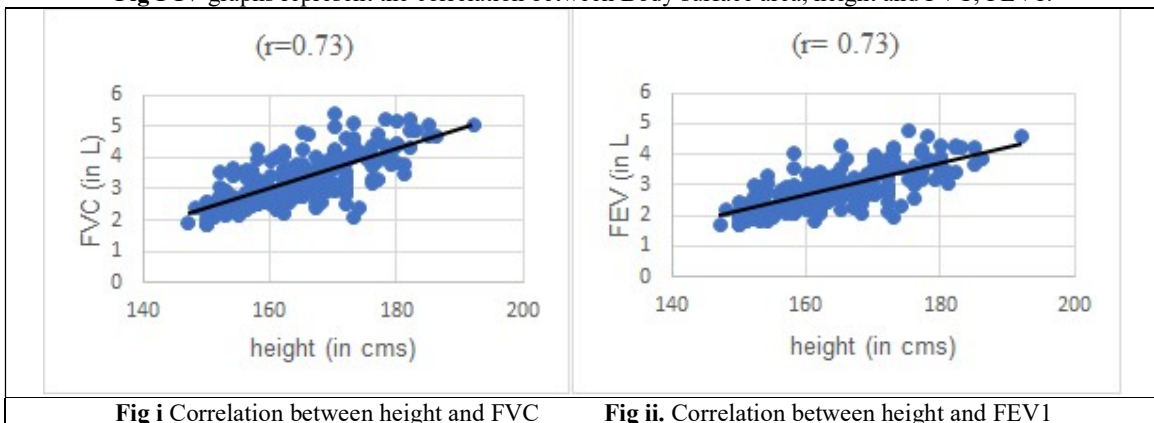
Table (II) Mean and standard deviation of pulmonary function parameters.

S no.	Variable	Overall (N=219)		Male (n=95)		Female (124)	
		Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
1	FEV1	2.96	0.64	3.34	.61381	2.90	0.56
2	FVC	3.40	0.79	3.86	.69	2.54	0.45
3	FEV1/FVC	87.62	6.07	87.18	5.30	88.66	5.59

Table (III) The correlation between anthropometric measurements and pulmonary function test with a p value of less than 0.05. * - denotes significant at 0.05, and ** - denotes significant at 0.01.

Variable	FVC(L)	FEV1(L)
Height	0.73**	0.73**
Weight	0.52**	0.50**
BMI	0.19**	0.15*
BSA	0.64**	0.59**
WC	0.34**	0.33**
HC	0.33**	0.32**
WHR	0.17*	0.17*

Fig I-IV graphs represent the correlation between Body surface area, height and FVC, FEV1.



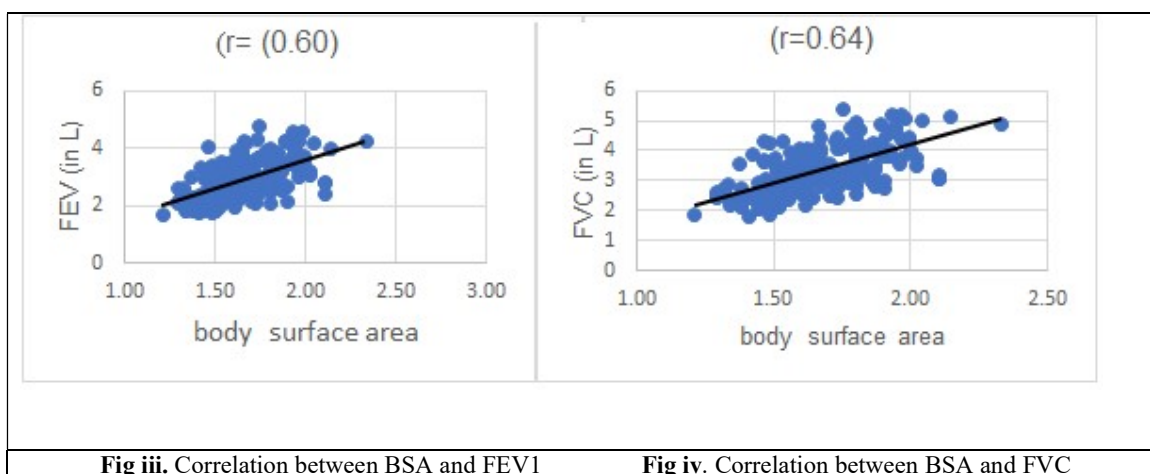


Fig iii. Correlation between BSA and FEV1

Fig iv. Correlation between BSA and FVC

DISCUSSION

The primary findings demonstrated a significant correlation between height, weight, and BSA with the pulmonary function of the participants. Conversely, other anthropometric measurements such as weight, BMI, WC, WHR, and HC showed weaker correlations with the pulmonary function test. Consistent with the findings of preceding data, in the present study, height demonstrated a strong correlation with FEV1 ($r = 0.73$) and FVC ($r = 0.73$)^(3, 13). This can be justified by the fact that reference values of lung function parameters are derived from the height and age of the subject. The age group included in this study ranging from 17 to 27 years. In previous studies, the age range was even narrower with much smaller sample size than our study^(26, 27). It is also reported that there is no significant correlation between obesity and pulmonary function⁽¹⁶⁾. A study on older subjects suggests that a reduction of fat in the trunk can improve lung function⁽²¹⁾.

Obesity is more prevalent in people with high socio-economic status and in urban population⁽²⁸⁾. It pertains to a sedentary lifestyle and unhealthy eating behavior. The revised obesity guidelines for individuals of Asian Indian descent incorporate assessments of waist circumference, waist-to-height ratio, comorbid conditions, and symptoms impacting daily functioning, in addition to BMI measurements⁽¹¹⁾. BMI is an indicator of abdominal obesity. Majority of our subjects' weight lies within the normal BMI range (76.71%). Some studies on the Indian population have proposed a BMI between 19-22 kg/m² as a cut-off for healthy people^(29, 30). After following this criterion, subjects having a normal BMI decrease from 76.71% to 32.87% in our study, which impacts heavily on defining the health among them. WC, BMI are reported to be positively correlated with fat mass percentage⁽³¹⁾. However, a study on north Indians claimed that their BMI is comparable to the western population⁽²⁹⁾. Our study revealed a modest yet favorable correlation between BMI and FEV1 and FVC, which is in contradiction to other study⁽²²⁾. Since the majority of our subjects possess a BMI within the normal range, thus limiting the results to a limited population.

BSA is utilized to ascertain the pharmacological dosage of medications. In critically ill patients with acute kidney injury, It also acts as a prognostic predictor for adverse outcomes⁽³²⁾. The Mosteller formula used in our study to calculate BSA provides more accurate values⁽³³⁾. BSA positively correlated with FEV1 and FVC, with correlation coefficient of 0.59 and 0.64, respectively. Apparently, only one study to date has reported correlation between body surface area and lung volumes⁽²⁶⁾.

The WHR has been identified as a reliable indicator of physical fitness levels, with a threshold exceeding 0.85, being deemed a significant risk factor. World Health Organization⁽³⁴⁾ has categorized WHR into three types based on its value⁽³⁴⁾. Females and males having a WC exceeding 80 cm and 90 cm respectively, are considered at increased risk of metabolic complications⁽²³⁾. Reduction of WC is desirable to mitigate adverse health risks among individuals⁽³⁵⁾. The relationship between WC, WHR and FVC, FEV1 was found to have a negative correlation in the reported data⁽²²⁾. In our study, the WHR was not correlated with either FEV1 or FVC. A study reports a negative correlation of WHR with pulmonary parameters⁽³⁶⁾. WHR was not associated with pulmonary function test parameters in another study⁽²⁾.

Although our study examined in depth all the parameters affecting the pulmonary function test, there were several limitations, Firstly, results could have been more reliable if the study was done on a larger sample size. As the age range was limited 17 to 27 years, it could not be generalized to subjects in other age groups. Secondly, the study predominantly included subjects with a normal BMI, limiting the applicability of the findings to obese individuals. Additionally, there was high variability in the number of subjects in underweight, normal, and overweight categories, preventing an analysis based on BMI classification. Thirdly, body fat distribution is an important factor in determining central adiposity. The study could not include body fat percentage and fat free mass, which could have provided more accurate and elaborate results. Finally, due to the small sample size, it is not possible to generalize the results to the population. A

future study with a larger sample size could yield more significant results.

CONCLUSION

The findings indicate that height, weight and body surface area are strongly associated with pulmonary function parameters in healthy young adults, highlighting their relevance in interpreting PFT outcomes. BSA is an important predictor of PFT. Analyses based on BMI classification and body fat percentage will give more elaborate results.

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Data availability –The datasets are not publicly available due to privacy of the subjects, but are available from the corresponding author on reasonable request.

DECLARATION

Conflict of Interest – The authors hereby declare that there do not have any competing interests.

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