ORIGINAL ARTICLE OPEN ACCESS

Association Between Body Composition Characteristics and Pulmonary Function Parameters in Young Adults of Shaheed Benazirabad District

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ABSTRACT

Background: Obesity is a significant global health issue linked to increased risks of respiratory diseases. This study examines the association between body composition metrics, such as Body Mass Index (BMI) and Waist-to-Hip Ratio (WHR), and lung function in adults aged 20-40 years.

Methods: A cross-sectional analysis was conducted at the Physiology Department of Peoples University of Medical and Health Sciences from February 2023 to April 2024, involving 376 adults. Participants were categorized based on their BMI and evaluated for WHR. Pulmonary function was assessed using spirometry, following American Thoracic Society guidelines. Statistical analysis was performed with SPSS version 27, utilizing Pearson's correlation coefficient and the chi-square test, with a p-value <0.05 considered significant.

Results: The sample consisted of 236 (62.8%) males and 140 (37.2%) females, with a mean age of 31.39±6.35 years. The mean BMI was 23.65±3.95 kg/m². Overweight individuals accounted for 220 (58.5%), and obesity for 85 (22.6%). Of the sample, 258 (68.6%) had reduced Vital Capacity (VC), 250 (66.5%) had decreased Total Lung Capacity (TLC), and 243 (64.6%) had decreased Forced Vital Capacity (FVC). A negative correlation was found between BMI and VC ($p<0.001$), as well as between WHR and VC.

Conclusion: Increased BMI and WHR are associated with respiratory function impairment. Weight loss and improved body composition may enhance respiratory health and reduce cardiovascular disease risk.

Keywords: Body Mass Index, Pulmonary Function, Obesity, Vital Capacity.

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Doi: https://doi.org/10.36283/ziun-pjmd14-1/004

How to cite: Naila H, Laghari ZA Association Between Body Composition Characteristics and Pulmonary Function Parameters in Young Adults of Shaheed Benazirabad District. Pak J Med Dent. 2025 Jan ;14(1): 17-23. Doi: https://doi.org/10.36283/ziun-pjmd14-1/004.

Received: Fri, September 27, 2024 **Accepted:** Sat, November 30, 2024 **Published:** Fri, January 10, 2025

INTRODUCTION

Obesity has become a global health challenge, increasing the risk of diseases such as diabetes, cardiovascular conditions, and cancer[1]. There are two primary types of obesity: overall obesity, assessed through body mass index (BMI), and abdominal obesity, evaluated via waist-to-hip ratio (WHR)[2-3]. Research indicates a potential link between obesity and impaired pulmonary function, which may heighten susceptibility to asthma[4]. Additionally, individuals with both asthma and obesity often experience more severe symptoms and require higher doses of medication, complicating disease management[5]. This has driven increased interest in understanding the relationship between body composition and respiratory function.

Studies examining the impact of obesity on pulmonary function have produced inconsistent results. Some findings indicate that severe obesity (BMI >40 kg/m²) is strongly associated with reduced lung volume[6], while reference values for lung volumes confirm that severe obesity corresponds with diminished pulmonary function[7]. Further evidence suggests that Forced Expiratory Volume in 1 second (FEV1) and Forced Vital Capacity (FVC) significantly decrease in markedly obese patients[8]. Conversely, other studies report no significant association between BMI and Vital Capacity (VC)[9], highlighting the variability in findings. Additional research links WHR with reduced spirometry values, showing a more pronounced effect in men[10]. Similar results have been observed for FVC and FEV1 values in relation to WHR[11]. The decline in static lung volumes, such as Total Lung Capacity (TLC) and Functional Residual Capacity (FRC), is notable due to mechanical restrictions caused by excess body fat[12-13]. These limitations hinder chest wall expansion and diaphragmatic movement, ultimately reducing lung volumes.

However, consensus on dynamic lung volumes like FVC and FEV1 remains limited. While some studies report significant reductions, others note minimal or no decline[14]. Central adiposity may exacerbate obesity-related effects on pulmonary function. For instance, studies assessing BMI and Body Fat Percentage (BF%) as predictors of obesity have demonstrated a significant correlation between higher body fat, central adiposity, and reduced pulmonary functions[15]. The current study, therefore, seeks to explore the relationships between body composition, BMI, WHR, and pulmonary function.

METHODS

The cross-sectional analytical study was conducted from February 2023 to April 2024 at the Department of Physiology, Peoples University of Medical and Health Sciences, examining the relationship between BMI and WHR with pulmonary function. The study included young adults aged 18 to 35 living in Shaheed Benazirabad, Sindh, across all BMI categories. According to the World Health Organization, a BMI of ≥25 kg/m² is considered overweight, and a BMI of ≥30 kg/m² is considered obese.

The sampling method used was non-probability convenience sampling. The inclusion criteria required participants to be within the specified age range and have no history of respiratory diseases to avoid confounding factors. Participants outside the age range, diagnosed with lung diseases, on respiratory medications, or pregnant were excluded. A total of 376 participants were selected based on a calculated sample size using G*Power software to ensure a 95% confidence interval and 80% power for detecting significant correlations.
Anthropometric measurements were taken under standardized conditions:

• Weight was recorded on a calibrated digital scale with minimal clothing and without shoes, while height was assessed using a stadiometer. BMI was calculated using the formula:

$$\textbf{BMI} = \frac{\textbf{Weight (Kgs)}}{\textbf{Height (m}^2\textbf{)}}$$

• WHR was measured by taking waist and hip circumferences using a non-elastic tape:

$$\textbf{WHR} = \frac{\textbf{Waist Circumference}}{\textbf{Hip Circumference}}$$

Pulmonary function tests were conducted using a SpiroLab spirometer, set according to American Thoracic Society standards. Parameters like VC, TLC, FVC, and FEV1/FVC ratio were recorded. Each subject performed spirometry three times to ensure reproducibility, with the best values used for analysis. Experienced technicians conducted all tests to minimize variation.

Data analysis was performed using SPSS version 27, calculating descriptive statistics (mean and standard deviation). Pearson's correlation coefficient and the chi-square test were used to assess associations between BMI, WHR, and pulmonary function. A p-value <0.05 was considered statistically significant. The study received institutional ethics approval, and participants gave informed consent.

RESULTS

The sample comprised 62.8% males and 37.2% females, with an average age of 31.39±6.35 years. Most participants (62.5%) were from the middle-income class, and 39.9% were active smokers. In terms of BMI, 58.5% were overweight, and 22.6% were classified as obese. The WHR indicated that 68.9% were in the high-risk category for cardiovascular disease (Table 1).

Table 1: Demographic and Anthropometric Characteristics

Variables	N (%)
Gender	
Male	236 (62.8)
Female	140 (37.2)
Age (Years)	
18 -24	41 (15)
25 - 35	235 (85)
Socioeconomic Status	
Low	118 (31.40
Middle	235 (62.5)
Upper	23 (6.1)
Smoking Status	
Smokers	150 (39.9)
Non-Smokers	226 (60.1)
Body Mass Index (BMI)	
Normal (18.5-24.9)	71 (18.9)
Overweight (25-29.9)	220 (58.5)
Obese (30) ≥	85 (22.6)
Waist-Hip Ratio (WHR)	
Low Risk (0.85≤)	19 (5.1)
Moderate Risk (0.86-0.95)	98 (26.1)
High Risk (>0.95)	259 (68.9)

The analysis of pulmonary function data reveals that a significant proportion of the study population (68.6%) exhibited diminished VC, in contrast to the 31.4% who maintained normal VC levels. Similarly, most participants demonstrated reduced TLC and FVC, with more than 60% of the subjects presenting with decreased values for both critical pulmonary parameters (Table 2).

Table 2: Frequency Distribution of Pulmonary Function Parameters

Category	Vital Capacity (VC) n (%)	Total Lung Capacity (TLC) n (%)	Forced Vital Capacity (FVC) n (%)	FEV1/FVC Ratio n (%)
Normal	118 (31.4%)	126 (33.5%)	133 (35.4%)	132 (35.1%)
Reduced	258 (68.6%)	250 (66.5%)	243 (64.6%)	244 (64.9%)

The results indicate a strong negative correlation between BMI and VC (p<0.001), suggesting that higher BMI is linked to decreased pulmonary function. Likewise, a significant negative correlation was found between WHR and VC (p=0.017), as demonstrated in (Table 3).

Table 3: Correlation Coefficients between BMI, WHR, and Pulmonary Functions

Variables	Vital Capacity	TLC	FVC	FEV1/FVC Ratio
BMI	-0.51*	-0.22*	-0.79	-0.06
p-value	<0.001	0.012	0.06	0.29
WHR	-1.18*	-0.13	-3.03	-0.05
p-value	0.017	0.86	0.47	0.92

The results from the frequency distribution analysis of VC about BMI and WHR reveal a significant association between increased body weight and compromised pulmonary function. Among individuals with a normal BMI, 55 exhibited average VC compared to 16 with reduced VC. In contrast, the overweight group showed a stark increase, with 56 having average VC and 164 being reduced. The obese category had only 7 with average VC against 78 with reduced VC. Similarly, WHR analysis indicated that individuals with severe WHR had the highest incidence of reduced VC, with 189 out of 259 participants affected. Chi-square tests confirmed these associations, with BMI showing a Chi-square value of 94.75 (p<0.001) and WHR a value of 32.05 (p<0.001), underscoring the critical link between elevated BMI and WHR and reduced pulmonary function, which could have significant implications for cardiovascular disease risk (Table 4).

Table 4: Frequency Distribution between BMI and WHR VC

Variable	Category	Vital Capacity Normal	Vital Capacity Reduced	Total	X^2	p-value
BMI	Normal	55	16	71	94.75	<0.001
	Overweight	56	164	220		
	Obese	7	78	85		
	Total	118	258	**376**		
WHR	Mild	7	2	9	32.05	<0.001
	Moderate	31	67	98		
	Severe	70	189	259		
	Total	108	258	**366**		

DISCUSSION

This study provides insights into the relationship between body composition and pulmonary function metrics in a group of 376 participants. The demographic analysis reveals that the majority, at 62.8%, are males with a mean age of 31.39 years. The study also found that most participants were overweight (58.5%) and obese (22.6%). In total, 68.9% had a high WHR, indicating increased cardiovascular disease risk.

One important discovery is the negative correlation between BMI and VC (p<0.001), suggesting that higher BMI is linked to decreased pulmonary function. Similar negative correlations were also found for WHR and VC (p=0.017), indicating that fat distribution, especially central obesity, impacts respiratory fitness. This suggests that interventions targeting BMI and fat distribution could benefit pulmonary function. The research also revealed a high prevalence of decreased pulmonary function indices: 68.6% had diminished VC, 66.5% had

reduced TLC, and 64.6% had reduced FVC. An impaired FEV1/FVC ratio was observed in 64.9%, suggesting widespread pulmonary dysfunction.

Our findings align with previous research[16], which reported that super-obese patients showed significant declines in TLC due to restrictive lung patterns. This highlights the impact of obesity on pulmonary function, as many overweight and obese participants demonstrated reduced lung function. Literature linking obesity to reduced pulmonary function is well-established. Increased BMI has been shown to correlate with lower FEC and FVC, indicating a restrictive lung pattern[17]. Similar observations have been reported[18, 19, 20], explaining that obesity leads to restricted aeration and reduced lung volumes due to airway inflammation and lung compression. Our results reinforce these findings, underscoring that excess body weight impairs pulmonary function.

Interestingly, no significant correlation was observed between weight and pulmonary function, suggesting that BMI and WHR serve as better indicators than weight. Nonetheless, the influence of smoking, socioeconomic factors, and other variables on pulmonary function warrants further investigation. BMI levels of 25.4–30.4 kg/m² were associated with a lower risk for OLD and COPD, consistent with the view that overweight individuals may experience protective effects on pulmonary function in these conditions. However, the prevalence of RLD and MLD did not differ across BMI groups, indicating varying associations with different lung disease types. Lower BMI was linked to poorer pulmonary function and higher COPD risk[21]. Associations between underweight and lower FEV1 values have also been reported[22, 23, 24], suggesting an increased risk of COPD. Interestingly, some findings suggest that overweight and obesity may protect against COPD, contributing to the "obesity paradox"[25-26]. Further research is needed to clarify these relationships. Overall, while certain lung diseases like COPD may show protection at higher BMI, obesity generally impairs pulmonary function. Future studies should examine the complex interactions between obesity, pulmonary function, and disease risk, taking into account factors such as fat distribution, lifestyle, and comorbidities. The study has limitations, including its cross-sectional design, which limits the ability to establish cause and effect. The participant pool, consisting of healthy individuals within a specific age and regional group, may not be representative of the broader population. Additionally, factors such as existing health conditions and physical activity levels were not accounted for, leaving gaps in understanding the link between obesity and lung function. Future research should adopt longitudinal approaches to better trace the relationship between obesity and pulmonary health and explore lifestyle modifications that could improve lung function in obese individuals.

CONCLUSION

The research highlights the critical relationship between body composition, specifically increased BMI and WHR, and pulmonary function deterioration in younger adults. Higher levels of BMI and central obesity are linked to significant reductions in respiratory capacities, including VC, TLC, and FVC. These findings emphasize the importance of public health strategies focused on maintaining healthy body composition and weight management to improve respiratory health. Addressing obesity-related issues is crucial in reducing respiratory morbidity and the risk of comorbidities. Future studies should explore causal relationships between body composition and pulmonary function and identify effective interventions to improve respiratory health.

LIST OF ABBREVIATIONS

BMI: Body Mass Index
WHR: Waist-to-Hip Ratio
VC: Vital Capacity
TLC: Total Lung Capacity
FVC: Forced Vital Capacity
FEV1: Forced Expiratory Volume in 1 second
FEV1/FV:C Ratio Ratio of Forced Expiratory Volume in 1 second to Forced Vital Capacity
OLD: Obstructive Lung Disease
COPD: Chronic Obstructive Pulmonary Disease
RLD: Restrictive Lung Disease
MLD: Mixed Lung Disease
FEC: Forced Expiratory Capacity
FRC: Functional Residual Capacity
BF%: Body Fat Percentage

ACKNOWLEDGEMENTS

None.

CONFLICT OF INTEREST

The authors declared no conflict of interest.

ETHICAL APPROVAL

The Institutional Review Board of the University of Sindh granted the study's ethical clearance, referenced as Physiol/356.

AUTHORS CONTRIBUTION

HN: Major contribution in writing the manuscript, data collection, and analysis. **ZAL:** Manuscript review and final approval.

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