ORIGINAL ARTICLE

Exploring the relationship between the impact of central obesity indices on forced vital capacity in young adult males

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Abstract

Background: Central obesity is a growing public health concern, particularly among young adults, and is associated with various metabolic and respiratory impairments. Forced Vital Capacity (FVC), a key measure of pulmonary function, may be adversely affected by increased central adiposity due to mechanical and inflammatory factors. Exploring the relationship between central obesity indices and FVC in young adult males can provide insights into early respiratory health risks and inform preventive strategies. *Aim and Objectives:* This study examines the association between central obesity and FVC in young adults. *Material and Methods:* This study employed a cross-sectional design after the institutional ethics committee approval. One hundred and six male participants diagnosed with central obesity and a Waist-to-Hip Ratio (WHR) > 0.90 were recruited from staff and student community aged 18-40 years. FVC was measured using an RMS Helios device. The assessment of height, weight, Body Mass İndex (BMI), Waist Circumference (WC), Hip Circumference (HC), WHR, fat percentage, and Fat Free Mass (FFM) were conducted using standard protocols. *Results:* Our study revealed no relationship between FVC, height, or BMI, WC, HC, WHR and FFM in the adults respectively with central obesity ($p > 0.05$). In contrast, we found a significant correlation between FVC with bodyweight ($p = 0.012$), height-weight ratio ($p = 0.017$), body fat percentage ($p = 0.026$) and fat mass ($p = 0.017$). *Conclusion:*According to the study findings, evaluating lung function in young adults with central obesity can reveal important details on the onset of lung illness.Furthermore, selected anthropometric measures can serve as biomarkers for identifying the onset of such disorders.

Keywords: Central Obesity, Forced Vital Capacity, RMS Helios, Anthropometric Indices

Introduction

Obesity is one of the serious health issue that causes approximately 300,000 deaths annually in the United States. Furthermore, it significantly increases the likelihood of various metabolic disorders, stroke, hypertension, gout, gallstones, colon cancer, sleep apnoea and non-alcoholic fatty liver disease, which is a threat to public health [1]. Central obesity, more prevalent in men, is characterized by the accumulation of fat in areas such as the front of the chest, abdominal walls, and around the intestines [2].

Anthropometry and body composition are influenced by diet, environment, and lifestyle [3]. Additionally, research has indicated that those who are obese or overweight are more prone to respiratory symptoms, even if they do not have lung disease. Research has indicated that obese people have more dyspnoea and wheezing at rest and during exercise in contrast to those with normal Body Mass Index (BMI) [4, 5]. When excess fat accumulates in the abdominal area around the stomach, abdomen, chest, and visceral cavity causes abdominal or central obesity, which adversely affects health. Central obesity can be assessed using several anthropometric metrics like Hip Circumference (HC), Waist Circumference (WC) and Waist-to-Hip Ratio (WHR). Among these indices, measuring a person's WC is the simplest and most accurate way to assess central obesity. WC is among the most accurate anthropometric measure of abdominal fat [6-8].

Numerous investigations have looked into the relation between respiratory function and central adiposity, including small airway obstruction, in young adults. Although the exact mechanisms linking obesity and lung function are not understood, some proposed mechanisms include mechanistic factors, inflammation, insulin resistance, and hormonal factors [9, 10]. Lung function may be impacted by central obesity, by compressing the diaphragm and limiting lung expansion, leading to a decrease in lung volume (mechanistic factors); abdominal adipose tissue (fat) releases inflammatory markers that lead to chronic airway inflammation and impair lung function (inflammation); obesity is associated with insulin resistance, which may have an impact on the airways and contribute to breathing problems (insulin resistance); and hormones produced by adipose tissue can impact lung function and inflammation.

The most often used metrics for characterizing obesity are BMI, WC, HC, and WHR. BMI often defines general obesity, while abdominal obesity is defined by WC, WHR, Waist-to-Height Ratio (WHtR), fat mass, and Body Fat Percentage (BFP). According to World Health Organization's Asian recommendations, general obesity is defined as BMI$\geq$ 30 kg/m^2[11], whereas abdominal obesity (central obesity) is defined as WHR $\geq$ 0.90 in men and WHR $\geq$ 0.85 in women, WHtR $\geq$ 0.5 in both genders, or BFP $\geq$ 25% in men and BFP $\geq$ 33% in women [12-14].

The severity of total obesity as a measure helps classify the severity of obesity. The abdominal or central obesity is associated with central fat localization and all-cause mortality [15]. The primary features of central obesity are an apple-like body shape, and fat deposition in the chest and abdomen. A pear-shaped torso and fat build-up in the hips, thighs, limbs, and subcutaneous tissue are characteristics of systemic or peripheral obesity. Because central obesity has a more direct impact on lung mechanics and metabolic inflammation than peripheral obesity, it's critical to distinguish between the various forms of obesity [16]. There is a direct correlation between central obesity and cardiovascular disease has been reported [17]. Abdominal obesity is more associated with cardiovascular disease-related metabolic disorders than general obesity [18]. Developing asthma due to abdominal obesity is a primary concern. In centrally obese people, it is crucial to evaluate respiratory function early on, including lung volume, lung capacity, and forced expiratory volume. The current study looked into the relationship between young individuals' forced vital capacity and central adiposity.

Material and Methods

This cross-sectional research was conducted after the institutional ethics committee approval (INST/2020/-539). This study included 106 centrally obese men between the ages of 18 and 40 years among the students and faculty members, by random purposive sampling technique. The sample size was calculated as per the formula: $n=Z^2.P(1-P)/d^2$, where 'Z' is the desired confidence level (95%), 'P' is the prevalence, and 'd' is the margin of error (10%) as we reported earlier (19). Written informed consent was obtained from all participants. Participants with a waist-hip ratio above 0.90 were included, while individuals with diseases, smokers, and those taking medications were excluded [19]. The current study included subjects selected from students and faculty members, as the study was short term and time bound.

Sample size was calculated by considering 5% alpha level and 80% power.

Participants were instructed to sit on a stool or stand erect while maintaining a relaxed posture. They were directed to look away from the computer monitor. Adequate instructions were provided to the participants, and the procedures were demonstrated, if necessary. The recording of Forced Vital Capacity (FVC) was carried out using the Pulmonary Testing Assistant software, RMS Helios—the "REC" button in the toolbar to start the recording. The participants were then instructed to position the mouthpiece, seal it with their lips, and secure their noses with a nose clip.

To record FVC, the participants were instructed to inhale and exhale rapidly and forcefully. The recording was stopped once the procedure was completed by clicking the "STOP" button in the toolbar. The FVC recording was repeated twice, and the best effort was chosen for further analysis.

Each participant's height was determined using a stadiometer. The measuring tape was fixed to the wall, and the participants stood barefoot with their hands hanging freely by their sides. The heels were positioned together, ensuring the scapula and buttocks were in contact with the measuring wall. The height was noted to the closest 0.1cm.

Each participant's weight was determined using a weighing scale. The scale was zeroed before taking the weight, and the participants were told to remove their shoes. BMI also known as Quetelet's index was calculated by dividing body weight (in kg) from square of height (in meters). It is a simple measure that reflects an individual's adiposity. Based on BMI values, individuals were classified as normal (18.5 to 24.9), overweight (25 to 29.9), moderately obese (30 to 39.9), or severely obese (>40). Waist circumference was measured at the narrowest part of the abdomen, between the ribs and the highest point of the iliac crest. The hip circumference was measured at the greatest circumference of the buttocks using a metallic measuring tape.

The WHR is calculated as the ratio of waist circumference to hip circumference. The BFP was calculated using Deurenberg's equation, which considers age and gender. The formula is as follows: % body fat = (1.2 × BMI) + (0.23 × Age) - (10.8 × Sex) - 5.4. Here, "sex" is substituted with 1 for males and 0 for females. The fat mass in kilograms was calculated using the formula [(weight/ 100) × % fat], and fat-free mass in kilograms was calculated as "body weight minus fat mass". The data was reported as mean ± Standard Deviation (SD). Graph Pad Prism Version 8.0 was used to analyse the data for statistical significance using the Pearson correlation test to determine the relationship between FVC and other obesity indicators, considering $p < 0.05$ as significant.

Results

Our study analysed data from 106 male participants in good health with central obesity between the ages of 18 and 40.We employed the Pearson correlation test to assess our statistical data to ascertain the connection between FVC, which measures the greatest amount of air that may be forcefully and rapidly exhaled after a deep breath, and anthropometric indices.

The demographic features of all the participants are described in Table 1. Pearson's correlation test showed a significant correlation of FVC with body weight (1A) and height-weight ratio (1B) $p = 0.012$ and $p = 0.017$, respectively (Figure 1). However, height and BMI did not show correlation with FVC.

Table 2 provides a comprehensive overview of the relationship between height, BMI, WC, HC, WHR, FFM, and BFP.

Figure 1A illustrates a statistically significant relationship between body weight and FVC. This demonstrates that in young adult males with central obesity, FVC rises as weight increases.

Similarly, a noteworthy discovery was noted, as seen in Figure 1B suggesting a link between height and weight, and their correlation with higher FVC values.

The relationship of FVC with fat mass, waist-to-hip ratio, hip circumference, and waist circumference was insignificant. This suggests that these anthropometric indices may not be reliable indicators of individual FVC in this population. Furthermore, in young people with central obesity, there was a strong correlation between FVC and BFP (Figure 3A, $p = 0.026$) and fat mass (Figure 3B, $p = 0.017$). This indicates that in this demographic, a person's FVC may be impacted by body fat or fat mass alone.

Table 1: Demographic details of participants included in the study (N=106)

Characteristics	N	Percentage (%)
Demographic domain		
Gender		
Male	106	100
Age (Years)		
18-24	72	68
25-35	25	24
36-40	09	8
Social domain		
Marital status		
Unmarried	84	79
Married	22	21
Employment status		
Studying	78	74
Employed	28	26
Unemployed	Nil	0
Educational status		
<High school	Nil	0
High school but <college	14	13
≥College	92	87
Clinical domain		
Hypertension	Nil	0
Congenital heart disease	Nil	0
Diabetes	Nil	0
Smokers		
Former smokers	05	4.7
Very rarely smokers	05	4.7
Never smokers	96	90.6

Table 2: Correlation between the FVC with anthropometric parameters in young adult centrally obese males (N=106)

Correlation of		Pearson Correlation		95% CI	*p* (2 tailed)
		r value	r^2		
Forced Vıtal Capacıty with	Weight	0.2284	0.0522	0.039 to 0.402	0.012 *
	HWtR	-0.230	0.053	-0.403 to -0.041	0.017*
	% Body Fat	0.2163	0.046	0.026 to 0.391	0.026*
	Fat Mass	0.230	0.053	0.041 to 0.403	0.017*
	Height	-0.0938	0.008	-0.279 to 0.098	0.338, NS
	BMI	0.1854	0.034	-0.05 to 0.363	0.057 NS
	WC	0.064	0.004	-0.127 to 0.252	0.571 NS
	HC	0.1508	0.022	-0.04 to 0.332	0.122 NS
	WHR	0.030	0.009	-0.170 to 0.229	0.76 NS
	Fat Free Mass	-0.081	0.006	-0.267 to 0.111	0.408 NS

*Note: In young adult centrally obese males, the Pearson correlation of FVC with Body Weight, Height to Weight Ratio (HWtR), % Body Fat, and Fat Mass revealed a significant association (p <0.05). In contrast, there was no significant association (p>0.05) between height, Body Mass İndex (BMI), Waist Circumference (WC), Hip Circumference (HC), Waist Hip Ratio (WHR), and fat free mass. * denotes a significant association.*

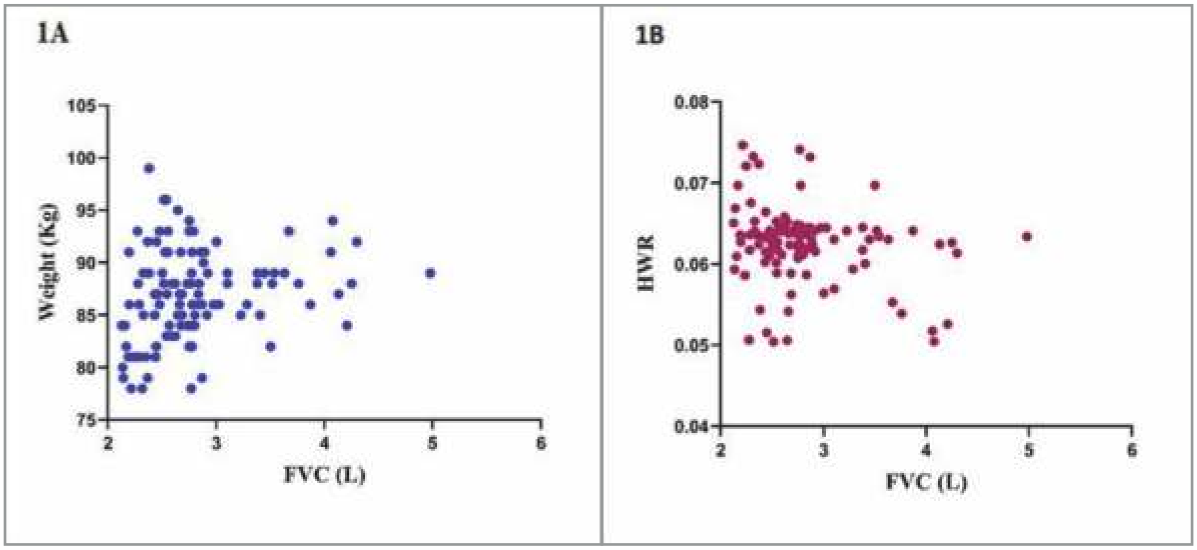

Figure 1: Correlation of FVC with Body Weight (1A) and Height-Weight ratio (1B) showed a significant correlation, *p* = 0.012 and *p* = 0.017 respectively.

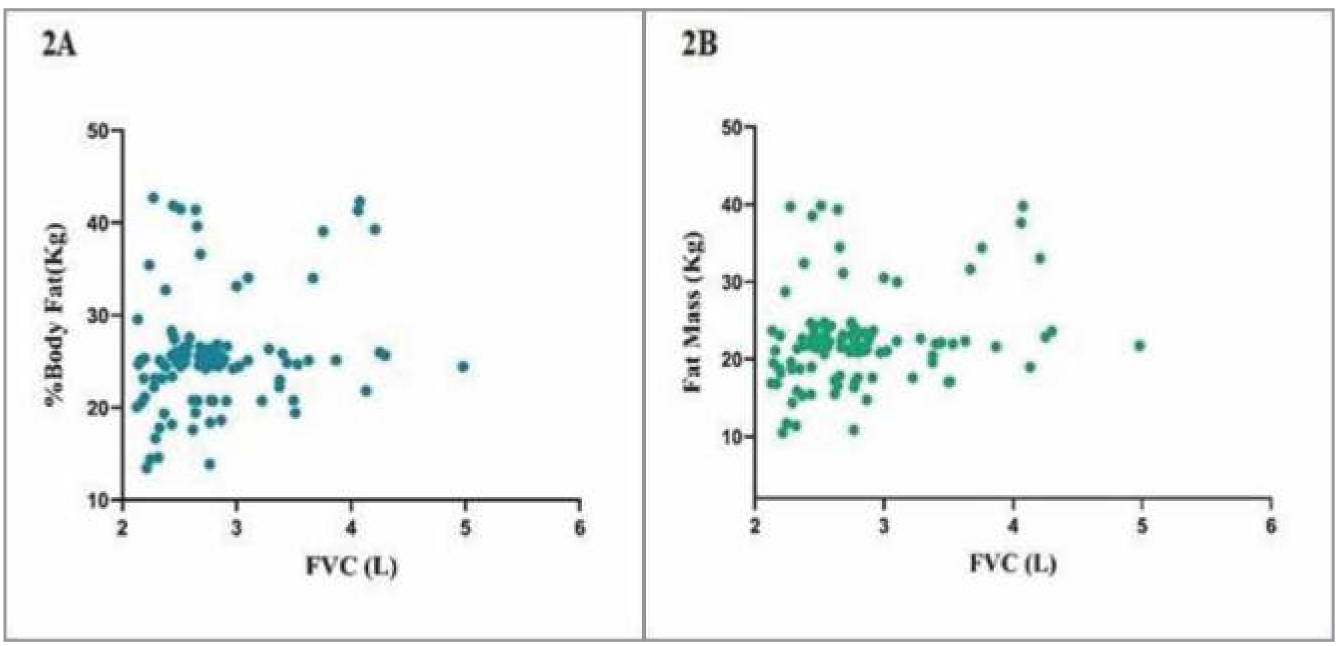

Figure 2: Correlation of FVC with percentage body fat (2A) and fat mass (2B) in young adult centrally obese males exhibited significant association by Pearson correlation test (*p* = 0.026 and *p* = 0.017) respectively.

Discussion

The prevalence of obesity as a nutritional disorder has emerged as a major health problem in developing countries such as India, which requires a comprehensive understanding of its impact [19-20]. One valuable tool widely used to address this problem was the evaluation of lung function by spirometry, which remains an indispensable technique in respiratory medicine. In order to better understand respiratory function, researchers and doctors should take FVC into account. In order to diagnose and treat respiratory disorders promptly and, eventually, to stop the disease's development, early identification of anomalies in lung function is essential. There has been a surge in interest in the practical screening tests that incorporate spirometric measures due to the significance of early diagnosis of anomalies in pulmonary function [21]. It was reported that WHR and WHtR are the best predictors of FVC and forced expiratory volume, and both male and female obese subjects had considerably lower levels of all respiratory indices [22]. Our study's findings indicate that human FVC is not directly impacted by height. Likewise, a person's FVC may not be accurately predicted by their BMI. Significant correlations were found between FVC and body weight, height-to-weight ratio, BFP, and fat mass, suggesting that these variables may have an impact on lung function in young people with higher levels of central obesity.

The link between lung function indices and abdominal obesity, such as the WHR, has been the subject of several research. The WHR is commonly used anthropometric measure to evaluate central obesity, linked to a decline in lung function [23-24]. The respiratory system may be impacted by mechanical and metabolic changes brought on by increased abdominal fat deposition, which is shown by higher waist-to-hip measurements. Increased abdominal adipose tissue may be one of the mechanisms behind the reduced lung function in central obesity [23]. The diaphragm and lungs may experience pressure from this extra fat build-up around the belly, which would restrict their ability to expand when breathing. Reduced lung function may arise from blockage of the tiny airways caused by this mechanical impact. Chronic inflammation may also be exacerbated by the release of several anti-inflammatory factors by adipose tissue, particularly in the abdominal region. Lung function may deteriorate as a result of airway constriction brought on by pro-inflammatory chemicals' persistent inflammation [24].

Another study showed that, the peak expiratory flow rate was much lower than that of control groups that are matched for age, weight, and height [25]. Further, unhealthy eating habits and inadequate physical activity were lifestyle risk factors for high blood pressure [26]. Our study's findings corroborate those of other researchers who have demonstrated that there is a real correlation between increasing obesity and decreasing lung capacity [27-29]. This is probably because there is more fat deposition around the chest wall and belly, which reduces lung compliance. The results indicate that the effects of central adiposity on forced vital capabilities are evident even in young males. But it's crucial to keep in mind that correlation does not always indicate causation, as the observed link may be influenced by additional factors. Physical activity, smoking, and dietary choices are examples of lifestyle variables that can have a substantial impact on lung function and obesity [30]. The confounding factors in the current study may be ethnicity, physical activity level, dietary habits, socioeconomic status, and environmental factors such as air quality. Furthermore, there may be individual differences, thus not everyone with central obesity will inevitably have lung failure. Therefore, even though our study's findings provide insight into the connection between young obese men's anthropometric indices and FVC, more research is required to fully examine the complex link between obesity and lung function.

Conclusion

When evaluated for FVC, young adult males with central obesity showed significant associations with body weight, height-weight ratio, BMI, and BFP. On the other hand, there was no discernible relationship between FVC and height, BMI, HC, WHR, or fat-free mass. This suggests that pulmonary function testing can provide important insights into the onset of lung illness in centrally obese young individuals. These results provide insight on the relationship between anthropometric and FVC indices and how it relates to the management and treatment of central obesity. Confirming and elucidating the relationship between FVC and anthropometric indices, as well as considering these identifiers as prospective biomarkers for evaluating lung disorders, will need a cross-sectional investigation with a bigger sample.

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