Research article

ASSOCIATION OF BODY WEIGHT ON PULMONARY FUNCTION TESTS IN YOUNG INDIVIDUALS (AGED 18- 40 YEARS)- A CROSS-SECTIONAL STUDY

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ABSTRACT

This was a prospective cross-sectional study conducted to evaluate association of waist, hip and thigh circumferences on respiratory parameters among young healthy adults. A total of 180 volunteers of different weight categories; including underweight, normal weight, over weight and obese people were recruited by using non-probability convenient sampling technique. Non-smoker males and females (non-pregnant), aged between 18-40 years with no pulmonary and cardiac disease were included in the study. Waist circumference, mid-thigh circumference, hip circumference and respiratory parameters were measured. The results showed a significant association between waist circumference with forced vital capacity (FVC) ($r = 0.188$, $p = 0.011$), average tidal volume (VT) ($r = 0.160$, $p = 0.032$), inspiratory reserve volume (IRV) ($r = 0.388, p<0.001$), vital capacity (VC) ($r = 0.312$, $p<0.001$), total lung capacity (TLC) ($r = 0.385$, $p<0.001$), and functional residual capacity (FRC) ($r = 0.477$, $p<0.01$), and a negative association with forced expiratory volume in 1 second (FEV1) ($r = -0.148$, $p = 0.048$) and FEV1/FVC ratio ($r = -0.246$, $p<0.001$). Significant association was not observed between waist circumference and expiratory reserve volume (ERV) ($r = 0.071$, $p = 0.344$). In the present study, increased waist, hip, and thigh circumferences were found to be negatively associated with FEV1 and FEV1/FVC ratio. Spirometry should be performed in obese and overweight young healthy adults even if they are asymptomatic, as early preventive measures can be taken to reduce the resulting morbidity.

Key Words: Anthropometry, spirometry, obesity, healthy adults

INTRODUCTION

The growing rate of obesity is a global public health issue, where prevalence of obesity in United States of America (USA) has been reported to be about 36% in adults while in children and adolescents it is reported to be 16.9%(1). Data from the Middle Eastern countries shows obesity prevalence exceeding 40%(2). The rise of the rate of obesity was obvious in a pooled analysis, where in 2016 there were 124 million as compared to 11 million children and adolescents were falling in the obese category in 1975(3,4). According to a National Health Service survey conducted in 1990-94 the prevalence of obesity in Pakistan was 1% while that of overweight was 5% in 15-24 years age group. This survey also showed that the prevalence of obesity in rural areas was 9% among adult males while it was 14% among adult females however in urban areas it was 22% among adult males and 37% among adult females (5). In

2013 the prevalence of obesity in rural areas was found to be 11% among men and 23% in women, while in urban areas, it was found to be 23% in men and 40% in women(6).
Body mass index (BMI) is a standard to measure obesity more commonly than body fat percentage. Waist and hip circumferences can be used to estimate the degree of obesity. Regional fat distribution i.e. abdominal obesity appears to be more influencing associated with comorbidities showing strong association with metabolic syndrome and related consequences (7). Waist circumference (WC) is a valuable tool for the detection of obesity and it is very simple to perform as it can be measured without taking height into account. The WC gives the idea about the fat stores in abdomen as well as total body fat (8). For the assessment of obesity, measurements of waist circumference or waist-to-hip ratio are valuable tools because, reducing central adiposity may be more difficult than just reducing overall body weight. More effort is needed to improve the diet and physical activity for the reduction of fatty tissue in persons having abnormal waist-to-hip ratio(9).
As compared to BMI, WC predicts lung function well. The persons, who have normal WC, are found to have normal values of Forced Expiratory Volume in 1 second (FEV1) and Forced Vital Capacity (FVC) (10). There is limited literature available to study the relationship of fat distribution of a body on respiratory parameters including healthy individuals or people with normal BMI. Therefore, this study was conducted to evaluate the fat distribution influencing lung function among apparently healthy obese, normal weight, underweight and overweight population.

METHODOLOGY

This was a cross-sectional study conducted in Physiology department of Liaquat University of Medical and Health Sciences (LUMHS), Jamshoro, Sindh. One hundred and eighty individuals, including males or non-pregnant females, aged between 18-40 years were recruited by using non probability convenient sampling technique. Sample size was calculated by open epi version 3.01 software, with 95% confidence interval and 5% precision. All recruited volunteers were non-smokers and had no known pulmonary, chest or cardiac anomalies, and did not work in the dusty environment. Invitation posters for volunteers were pasted at different locations in the premises of the University.
Age, gender, height and weight were recorded, after taking written informed consent. Spirometry test was performed using Power lab, model 15T (AD instrument-Australia) to check respiratory parameters in standing position, wearing clip on nose to prevent air leakage. For accuracy three readings were taken and both static and dynamic lung volumes and capacities were recorded. The recorded parameters were forced vital capacity(FVC) (i.e., total exhaled air), Tidal Volume (VT) i.e., air inhaled and exhaled during normal inhalation, Inspiratory Reserve Volume (IRV) i.e., extra quantity of air inhaled till maximum inspiration, Expiratory Reserve Volume (ERV) i.e., extra quantity of air exhaled till maximum expiration, Vital Capacity (VC) i.e., maximum amount of air exhaled till maximum inspiration, Forced Expiratory Volume in one second (FEV1) i.e., breathe out in one second during enforced outbreath after forced inspiration, Total Lung Capacity (TLC) i.e., one can inspire maximum amount of air, Functional Residual Capacity (FRC) i.e., amount of air exists in lungs till normal expiration and inspiratory capacity (IC) i.e; amount of air inhaled through a deep inhalation. All the parameters were calculated in liters and FEV1/FVC ratio was calculated. Waist circumference (WC) was measured around the belly at the level of the umbilicus.

Hip circumference is the broadest circumference over the buttocks measured with measuring tape. These measurements were used to calculate the waist hip ratio (WHR) also. Then mid-thigh circumference was measured on the right side of body, midway between top of femur and top of the tibia.

Statistical Methods

Statistical Package for Social Sciences (SPSS version 22.0) was used to analyze the collected data. For anthropometric parameters such as waist circumstance (WC), thigh circumference (TC), and waist to hip ratio (WHR) mean and standard deviation were calculated. To compare the mean of respiratory parameters; t-test was applied that includes FEV1, FVC & TLC between higher and lower WHR, WC, TC and Hip circumference. Analysis for correlation was done to observe the association between respiratory parameters and body fat-distribution (WHR, TC, WC, and HC). P-value < 0.05 was taken as statistically significant level.

RESULTS

Demographic Characteristics

Out of 180 participants, 94 (52.2%) were males and 86 (47.8%) were females and their mean age was 21.83(SD±5.88) years, whereas their mean weight was 66.12 (SD± 21.30) Kg, mean height was 2.85(SD±0.33) m^2, and mean BMI was 25.10(SD±6.55)kg/m^2,whereas majority of them were either overweight 58(32.2%) or obese 47(26.1%). 41(22.87%) participants had normal weight whereas 34(18.9%) were underweight.

Correlation of Respiratory parameters and fat distribution

The FVC was significantly correlated with waist circumference (r=0.188, p=0.011), hip circumference (r=0.169, p=0.024), thigh circumference (r=0.217, p=0.003) and waist-hip ratio (r=0.208, p=0.005). FEV1 (L) was significantly correlated with waist circumference (r=-0.148, p=0.048), hip circumference (r=-0.160, p=0.032), and thigh circumference (r=-0.166, p=0.026). FEV1/FVC ratio was significantly correlated with waist circumference (r=-0.246, p=0.001), hip circumference (r=-0.242, p=0.001), thigh circumference (r=-0.279, p<0.001), and waist-hip ratio (r=-0.188, p=0.011).

Average VT (L) was significantly correlated with waist circumference (r=0.160, p=0.032), hip circumference (r=0.308, p<0.001), thigh circumference (r=0.268, p<0.001), and waist-hip ratio (r=-0.179, p=0.016). IRV (L) was significantly correlated with waist circumference (r=0.388, p<0.001), hip circumference (r=0.459, p<0.001), and thigh circumference (r=0.384, p<0.001). ERV (L) was significantly correlated with waist-hip ratio (r=0.191, p=0.01). IC was significantly correlated with waist circumference (r=0.310, p<0.001), hip circumference (r=0.455, p<0.001), and thigh circumference (r=0.371, p=<0.001). VC (L) was significantly correlated with waist circumference (r=0.312, p<0.001), hip circumference (r=0.431, p<0.001), and thigh circumference (r=0.370, p<0.001).

TLC (L) was significantly correlated with waist circumference (r=0.385, p<0.001), hip circumference (r=0.514, p<0.001), and thigh circumference (r=0.443, p<0.001). FRC was significantly correlated with waist circumference (r=0.477, p<0.01), hip circumference (r=0.521, p<0.01), thigh circumference (r=0.462, p<0.001), and waist-hip ratio (r=0.193, p=0.001) (Table1).

Table 1: Impact of Fat Distribution on Pulmonary Function Parameters

Pulmonary Function Parameters	Fat parameter (n=180)							
	Waist Circumference (inch)		Hip Circumference (Inch)		Thigh Circumference (Inch)		Waist-Hip Ratio	
	R	p-value	R	p-value	R	p-value	r	p-value
FVC (L)	0.188	0.011	0.169	0.024	0.217	0.003	0.208	0.005
FEV1 (L)	-0.148	0.048	-0.160	0.032	-0.166	0.026	0.041	0.580
FEV1 / FVC (%)	-0.246	0.001	-0.242	0.001	-0.279	<0.001	-0.188	0.011
Average VT (L)	0.160	0.032	0.308	<0.001	0.268	<0.001	-0.179	0.016
IRV (L)	0.388	<0.001	0.459	<0.001	0.384	<0.001	0.108	0.149
ERV (L)	0.071	0.344	-0.027	0.716	0.018	0.811	0.191	0.01
IC (L)	0.310	<0.001	0.455	<0.001	0.371	<0.001	-0.090	0.230
VC (L)	0.312	<0.001	0.431	<0.001	0.370	<0.001	-0.043	0.569
TLC (L)	0.385	<0.001	0.514	<0.001	0.443	<0.001	-0.012	0.869
FRC (L)	0.477	<0.01	0.521	<0.01	0.462	<0.001	0.193	<0.001

DISCUSSION

Our study showed that waist circumference had a significant positive association with FVC, average VT, IRV, VC, and FRC and had a significant negative association with FEV1 and FEV1/FVC ratio, while waist circumference was found to have no correlation with ERV. Our results were similar to an earlier study showing FEV1 and FVC were negatively correlated with adiposity markers and among them WC was statistically significant (11), whereas in another study an inverse relationship between WC and

FEV_1 was reported, while forced vital capacity was also found to be negatively associated with waist circumference (12). The results of FVC were different from our study; this difference in findings may be attributed to older age criteria in the later study.

The Hip circumference was found to be significantly positively associated with FVC, average VT, IC, TLC, IRV, FRC, and VC; whereas significantly negative association was found with FEV1 and FEV1/FVC ratio, while association with ERV was shown to be negative but was not statistically significant. Thigh circumference was observed to have a significant negative association with FEV1, FEV1/FVC ratio, but there was no association was seen with ERV; wherein all other parameters were shown to have had a significant positive association with thigh circumference. Waist-Hip ratio was found to be a significant positive association with FVC and FRC though there was no association with FEV1, IRV, VC and TLC was found. Various similar studies have reported WHR to have a significant negative correlation with pulmonary function parameters (13), an earlier study showed VC, FEV1, FVC and PEF to have a negative correlation with high WC as compared to group having comparatively low WC (14). Like our study findings, another study also reported a positive association of WHR with forced vital capacity, total lung capacity, and FRC (15), while unlike our study, FVC and FEV_1 have been reported to have a negative correlation with WHR (16), this difference in findings may be due to inclusion of both younger and older adults in that study as opposed to our study. Unlike our study, a study done in Egyptian adolescents showed that waist circumference or WHR had no significant correlation with pulmonary functions(17); these dissimilar results could be due to different age criteria of the study participants as children aged 6 to 16 years were included in that study.

Our study is novel for including healthy volunteers in order to portray true picture of the relationship. However, a small sample size and non-probability convenient sampling technique can be taken as limitations of the study. Considering the views of our study and to what extend these correlations may be consistent with the gender variations would be revealing to uncover more facts about it.

CONCLUSION

Our study showed that increased waist, hip and thigh circumferences were had a negative association with FEV1 and FEV1/FVC ratio, indicating obstructive pattern in these young adults. It is thus recommended that spirometry should be performed in obese and overweight young adults even if they are asymptomatic, as measures can be taken to reduce the resulting morbidity. More researches with large number of sample size are recommended to look at the long term effects of body fat on pulmonary function.

Ethical Consideration: The study was approved by the Ethical committee of Liaquat University of Medical & Health Sciences, Jamshoro, Pakistan

Conflict of Interest: There is no conflict of interest.

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