RESEARCH ARTICLE

Waist circumference and waist-hip ratio as a predictor of respiratory risk factor

Divyashree, Suhas Y Shirur, Veena H Chandregowda

1Department of Physiology, Adichunchanagiri Institute of Medical Sciences, Mandya, Karnataka, India, 2Department of Physiology, Kodagu Institute of Medical Sciences, Madikeri, Karnataka, India

Correspondence to: Divyashree, E-mail: kumarhv4@gmail.com

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ABSTRACT

Background: The prevalence of Abdominal Obesity as well as of Generalized Obesity are high in India. Obesity can directly alter respiratory physiology through a variety of processes and can lead to reduction in lung function. The quantity and location of body fat alter the impact of obesity on pulmonary function. Waist circumference (WC) links to intra-abdominal and subcutaneous fat and it is a better scale of intra-abdominal fat.

Aim and Objectives: (1) To determine the effect of anthropometric parameters like WC, waist-hip ratio (WHR) on timed vital capacity in adult. (2) To determine the difference in timed vital capacity between males and females.

Materials and Methods: 150 apparently healthy adults aged 20–40 years were selected for the study. WC, Waist-hip ratio were measured. Pulmonary functions such as Forced Vital Capacity, Forced Expiratory Volume in one second, (FEV1/FVC%) were recorded using Computerized Spirometer (RMS HELIOS 401). Data were statistically analyzed by unpaired t-test, Karl Pearson’s coefficient of correlation test, statistical significance was considered for P < 0.05.

Results: FVC, FEV1 were significantly declined in both male and female subjects in the group II compared to group I in terms of both WC and WHR. FVC, FEV1 were significantly higher in males when compared with females. Significant negative correlation observed between FVC and FEV1 values with Group II of WC and WHR. Conclusion: To conclude obesity even in the absence of specific pulmonary disease, alters the pulmonary function, that can lead to long-term consequences. Regular exercise, yoga, pranayama help to reduce weight and improve breathing by strengthening respiratory muscles.

KEY WORDS: Waist Circumference; Waist Hip Ratio; Timed Vital Capacity

INTRODUCTION

Obesity prevalence is increasing at an alarming rate and a growing epidemic over the world.[1] Overweight and obesity are on the rise in countries such as India. India is the world’s second most populated country, and it is currently undergoing a rapid epidemiological transition in which under nutrition, which was common in the past due to poverty, is being rapidly replaced by obesity due to decline in physical activity and unhealthy eating habits. In India, the prevalence of both abdominal and generalized obesity was high.[2] Obesity is a widely recognised health risk because to its link with various metabolic problems such as dyslipidemia, hypertension, diabetes mellitus and cardiovascular risk, cancer, and, in particular, polycystic ovarian syndrome and infertility in young women.[3] Obesity can directly alter respiratory physiology through a variety of processes. For instance, fat buildup can mechanically affect diaphragm motion by invading into the chest wall or diaphragm, or it can affect diaphragm descent on forced inspiration. Fat accumulation between the ribs and muscles further limit the compliance of the chest wall, increasing metabolic needs and breathing effort even at
Obesity, specifically abdominal obesity, is a condition that contributes to decreased lung function and adds to the risk of developing health problems such as respiratory disorders, cardiac problems, and metabolic syndrome. Obesity in the abdomen impairs lung function by limiting diaphragmatic mobility, resulting in a reduction in the inspiratory muscles ability to expand the rib cage, increasing the risk of airflow limitations, respiratory diseases, and other medical complications, as well as longer hospital stays after surgery. Obesity can lead to decline of pulmonary function by its deleterious effects on the various processes involved in normal respiratory function. The respiratory problems most commonly related with central adiposity include obesity hypoventilation syndrome and obstructive sleep apnea syndrome. Dyspnea is common in obese persons, and although if they do not have lung illness, their pulmonary function tests are usually abnormal. Pulmonary function testing is an important step in determining the respiratory system’s functioning state. It gives clinical advice for recognizing and monitoring certain obstructive airway illness and restrictive respiratory diseases. The most common and useful pulmonary function test is spirometry, which measures the volume of inhaled and exhaled air as a function of time. Spirometry is a tool for determining the pattern, severity, and progress of respiratory disease, as well as assessing an individual’s respiratory health. Individual weight, height, age, gender, race, nutrition, body surface area, and environmental factors all have an impact on pulmonary function. Not only the body mass index (BMI), influences pulmonary function, the distribution of body fat also has an impact. Because of its simplicity, the BMI is often employed as a diagnostic of obesity, although it does not provide information on the distribution of body fat. Recent studies have focused on abdominal obesity and its effects on population health. The central obesity, which is measured by Waist circumference (WC), waist-hip ratio (WHR) connects to intraabdominal and subcutaneous fat and is considered as better scale for intra abdominal fat than BMI. Many studies have done to explain effect of BMI on respiratory function and a very few studies have been done to study effect of WC and WHR on respiratory mechanics of Indian adults. Hence we conducted a study with the objectives to determine the effect of anthropometric parameters like WC, WHR on timed vital capacity in adults, to determine the difference in timed vital capacity between males and females.

**MATERIALS AND METHODS**

This Cross-sectional Observational study was conducted on 150 apparently healthy adults both males and females falling in the age group between 20 and 40 years. Ethical clearance was obtained from the Institutional Ethics Committee with IEC No-1/2014, Date-26/11/2014.

Subjects with known history of respiratory diseases, cardiovascular and neuromuscular diseases, thoracic skeletal deformities such as kyphosis and scoliosis, individuals with present or past history (in the last 3 months) of upper respiratory or lower respiratory tract infection, individuals with a history of chronic exposure to substances which results in altered pulmonary function, history of smoking and alcohol consumption, subjects with considerable weight gain or loss in the past 3 months, subjects on drugs causing weight gain or weight loss and pregnancy were excluded from the sample. A detailed history was taken from all of the participants, followed by a clinical examination. The intention of the study and the process to be followed in the study were explained to each individual participating in the study and after that, they were asked to fill out a consent form.

WC was measured at a level midway between the lower rib margin and iliac crest with the tape all around the body in horizontal position. Hip circumference was measured as the maximal circumference over the buttocks. WHR was calculated by dividing WC by hip circumference and then subjects were assigned to WC and WHR subgroups based on the WHO cut-off point for WC and WHR for both males and females respectively. The study subjects were in both the genders divided into subgroups based on their WC and WHR. Based on WC into two groups.

- WC Group 1 - WC<88 cm for female and WC<102 cm for male
- WC Group 2 - WC ≥88 cm for female and WC≥102 cm for male

Based on WHR into two groups.

- WHR Group 1 - WHR<0.85 for female and WHR <1 for male
- WHR Group 2 - WHR ≥ 0.85 for female and WHR ≥ 1 for male

Pulse rate (beats per minute) is recorded by counting number radial arterial pulsation per minute. Blood pressure (mm of Hg) is recorded using mercury Sphygmomanometer. Respiratory rate (cycles per minute) is counting a chest movements in a clinical lab. The pulmonary function tests were recorded by using RMS HELIOS 401. This Spirometer has mouth piece, which is attached to the transducer and connected to the computer by serial cable. Software from RECORDER and MEDICARE SYSTEM loaded to the computer. Tests were recorded in sitting position at room temperature. Whole procedure was explained in detail to all the participants, that is they were instructed to inhale to their maximum capacity before placing the mouth piece between the lips creating a good air seal tight. The nose clip is attached following which, they were asked to perform expiration forcefully with maximum effort through the mouth piece and this was followed by maximum forceful inspiration. Then, the manoeuvre of spirometric procedure was demonstrated to all the subjects using Helios 401 spirometer. Then, they were allowed to practice the procedure of spirometry. The test was performed over three manoeuvres according to the American thoracic society association. 5–10 min of rest given in between the readings. The best reading out
Table 1: Anthropometric parameters of male and female subjects

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Male (n=75)</th>
<th>Female (n=75)</th>
<th>t-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>30.02±8.348</td>
<td>30.48±6.48</td>
<td>-0.371</td>
<td>0.711NS</td>
</tr>
<tr>
<td>Height</td>
<td>163.78±7.2564</td>
<td>156.42±4.75</td>
<td>7.350</td>
<td>0.00*</td>
</tr>
<tr>
<td>Weight</td>
<td>70.73±13.44</td>
<td>65.72±10.229</td>
<td>2.571</td>
<td>0.011*</td>
</tr>
<tr>
<td>BMI</td>
<td>26.81±4.34</td>
<td>26.88±4.306</td>
<td>-0.090</td>
<td>0.928NS</td>
</tr>
<tr>
<td>WC</td>
<td>91.093±10.081</td>
<td>84.626±10.8</td>
<td>3.791</td>
<td>0.000**</td>
</tr>
<tr>
<td>HC</td>
<td>97.053±6.1135</td>
<td>99.12±7.49</td>
<td>-1.851</td>
<td>0.066NS</td>
</tr>
<tr>
<td>WHR</td>
<td>0.9348±0.0821</td>
<td>0.8472±0.0526</td>
<td>7.777</td>
<td>0.000*</td>
</tr>
</tbody>
</table>

All values are expressed in Mean±Standard deviation, BMI: Body mass index, WC: Waist circumference, HC: Hip circumference, WHR: Waist hip ratio, *: Statistically significance on comparing among two groups at P<0.05, NS: Non significant, unpaired t-test.

Table 2: Comparison of Physiological parameters between males and females

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Male (n=75)</th>
<th>Female (n=75)</th>
<th>t-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PR</td>
<td>77.39±6.332</td>
<td>75.93±6.77</td>
<td>1.357</td>
<td>0.17 NS</td>
</tr>
<tr>
<td>RR</td>
<td>16±2.445</td>
<td>16±1.72</td>
<td>-1.657</td>
<td>0.100 NS</td>
</tr>
<tr>
<td>SBP</td>
<td>120.37±11.42</td>
<td>121.97±10.41</td>
<td>-0.896</td>
<td>0.371 NS</td>
</tr>
<tr>
<td>DBP</td>
<td>74.29±5.634</td>
<td>72.93±5.78</td>
<td>1.459</td>
<td>0.147 NS</td>
</tr>
</tbody>
</table>

All values are expressed in Mean±Standard deviation, PR: Pulse rate, RR: Respiratory rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, *Statistically significant at P<0.05, NS: Non significant, unpaired t-test.

DISCUSSION

Obesity is a chronic disease due to the abnormal growth of adipose tissue. Obesity is a disorder of caloric imbalance. Distribution of the fat due to weight gain alters the health risks associated with obesity, that is Abdominal fat distribution or Android obesity has increased risk whereas gynoid obesity with evenly and peripherally distribution of fat has less risk. BMI measures generalized obesity whereas WC and WHR measure abdominal obesity.[19] The present study results showed a highly significant decline in FVC, FEV1 in group II of WC (P<0.01, Tables 3 and 4) and WHR (P<0.01, Tables 5 and 6) compared to group I in both male and females. FVC, FEV1 significantly negatively correlated with WC and WHR in group II of both males and females (P<0.05, Table 7). FVC, FEV1 were significantly more in males compared to female. No significant difference in FFV1/FVC% was observed between subgroups of WC in both males and females and subgroups of WHR in males. FEV1/FVC% was significantly increased in females of WHR group II than with group I (P=0.028). FEV1/FVC% was significantly decreased in males compared to females (P=0.035).

The present study finding of FVC changes with WC is in concordance with previous studies.[20,21] Chen et al. observed on average, a 1 cm increase in WC was associated with a 13-mL reduction in FVC.[21] The present study findings of FVC changes with WHR similar to Study conducted by Sorani et al. in their study have found FVC and ERV were significantly decreased in subjects with higher WHR and FVC was negatively correlated with WHR in obese group (P<0.001). They concluded abdominal adiposity is a better predictor of pulmonary function than the body fat percentage or BMI.[22] Diaphragmatic muscle Overstretching caused by diaphragmatic domes elevation produced by visceral fat can decrease the diaphragmatic muscle contractile efficiency.[23] Present study findings of effect of WC on FEV1 comparable to the findings of study conducted by Soundariya and Neelambikai colleague[14] Shaheen et al. in their study found FEV1 had significant negative correlation with WC in higher WC group and with higher WHR group.
in females. on average 1cm increase in WC was associated with 4.3 ml reduction in FEV1 value. They concluded trunk obesity as measured by WC, WHR and Abdominal circumference are more significant predictor to ventilatory function than BMI measures overall obesity.[24] Considering to the relationship between obesity status and lung function, the results indicate that there is a negative correlation between obesity status and FEV1%. The FEV1 parameter is well known as a strong predictor of lung impairments and airway function.[25] Swasti Banerjee and co-investigator’s in their study observed weakly positive correlation of FEV1 and PEFR with Weight, WC, WHR.[26] So in the present study pulmonary function tests parameters FVC, FEV1 except FEV1/FVC% showed significant inverse relation with higher WC and higher WHR. This indicates that overall obesity measured by WC, WHR alters the pulmonary function which may give rise to long-term complications and associated with early mortality and morbidity. Accumulation of adipose tissue also produces a large number of the pro-inflammatory mediators that is contribute to the increase in airway inflammation and loss of lung viscoelasticity resulting in the reduction of lung function.[6] Strength of the present study is we determined the lung function changes with WC and WHR which are the better parameters to assess intra abdominal fat, correlated lung function parameters between WC and WHR Subgroups, Limitations are sampling method we adopted was convenient sampling and small sample size, generalizability would be more with probability sampling method, large sample size.
Table 7: Correlation between anthropometric indices and FVC, FEV1, FEV1/FVC tests in males and females

<table>
<thead>
<tr>
<th>Anthropometric indices</th>
<th>WC in males</th>
<th>WC in Female</th>
<th>WHR in Male</th>
<th>WHR in Female</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group I</td>
<td>Group II</td>
<td>Group I</td>
<td>Group II</td>
</tr>
<tr>
<td></td>
<td>R (P-value)</td>
<td>R (P-value)</td>
<td>R (P-value)</td>
<td>R (P-value)</td>
</tr>
<tr>
<td>FVC</td>
<td>0.018</td>
<td>−0.532*</td>
<td>0.317*</td>
<td>−0.400*</td>
</tr>
<tr>
<td></td>
<td>0.065</td>
<td>−0.479*</td>
<td>0.371*</td>
<td>−0.384*</td>
</tr>
<tr>
<td></td>
<td>0.897</td>
<td>0.011</td>
<td>0.038</td>
<td>0.012</td>
</tr>
<tr>
<td></td>
<td>0.642</td>
<td>0.024</td>
<td>0.014</td>
<td>0.030</td>
</tr>
<tr>
<td></td>
<td>−0.207</td>
<td>−0.153</td>
<td>−0.192</td>
<td>−0.016</td>
</tr>
<tr>
<td></td>
<td>0.137</td>
<td>0.495</td>
<td>0.216</td>
<td>0.932</td>
</tr>
<tr>
<td>FEV1</td>
<td>−0.099</td>
<td>−0.554**</td>
<td>0.002</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>0.060</td>
<td>0.148</td>
<td>0.452</td>
<td>0.425</td>
</tr>
<tr>
<td></td>
<td>0.054</td>
<td>0.529</td>
<td>0.329</td>
<td>0.054</td>
</tr>
<tr>
<td>FEV1/FVC%</td>
<td>0.382</td>
<td>0.410**</td>
<td>0.038</td>
<td>0.030</td>
</tr>
<tr>
<td></td>
<td>0.329</td>
<td>0.155</td>
<td>0.382</td>
<td>0.032</td>
</tr>
<tr>
<td></td>
<td>0.180</td>
<td>0.045</td>
<td>0.065</td>
<td>0.045</td>
</tr>
</tbody>
</table>

All values are Karl Pearson’s correlation r-value, *: Statistically significant at P<0.05, NS: Non significant, WHR: Waist hip ratio, WC: Waist circumference, FVC: Forced vital capacity, FEV1: Forced expiratory volume in one second, FEV1/FVC%: Forced Vital Capacity/Forced Expiratory volume in one second%

CONCLUSIONS

In the present study, there is an inverse relationship between WC, WHR with pulmonary function. WC has been negatively and consistently associated with pulmonary function. Increase in WC may have an effect on diaphragm limiting its move. Even in the absence of specific pulmonary disease, obesity has an effect on lung function that can decrease respiratory well-being. Thus, close monitoring of respiratory symptoms, primary prevention, and early management in individuals who are obese should be given priority concern. Regular exercise and balanced diet decrease weight and improves respiratory function.

A larger sample size and a longitudinal study will definitely be greater value in predicting the interdependency of WC, WHR with respect to between pulmonary function parameters.

REFERENCES


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