Correlation of Obesity and Peak Expiratory Flow Rate in Young Adult Females

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Abstract

Background and Purpose: Pulmonary functions are determined by respiratory muscle strength, compliance of the thoracic cavity, airway resistance and elastic recoil of the lungs. Peak Expiratory Flow Rate (PEFR) is the maximum rate of airflow achieved during a forced expiration after maximal inspiration. Obesity can affect diaphragm, thoracic and abdominal muscles. Increased respiratory effort and impairment of gas transport system can result in altered pulmonary functions. In India, obesity has reached epidemic proportions in the 21st century, with 5% of the country's population being affected with morbid obesity. The prevalence of obesity among Indian women has increased from 10.6% to 12.6%, i.e. an increase by 24.52% in a seven year period. Markers of obesity such as Body Mass Index (BMI) and Waist Hip Ratio (WHR) may be correlated to PEFR. Thus, the aim of this study is to correlate the effects of obesity on pulmonary functions.

Objectives: To assess the effect of BMI on Peak Expiratory Flow Rate (PEFR) in young adult females. To assess the effect of WHR on Peak Expiratory Flow Rate (PEFR) in young adult females.To compare BMI and WHR as a measure of obesity in terms of correlation with PEFR

Design: Correlational study

Methods: 45 subjects between the age group of 20 to 40 years were recruited for the study. Written informed consent and institutional ethical clearance were obtained. Anthropometric measurements were obtained using the Quetelet index for BMI and WHR was derived by dividing the waist circumference from the hip circumference. PEFR was obtained using the Wright's portable peak flow meter in standing position. Results: Data has been derived using SPSS 16.0 software. Pearson's correlation coefficient test was used to find the correlation between BMI and PEFR and WHR and PEFR. Correlation coefficient for BMI and PEFR was $r = -0.48$ and is statistically significant ($p < 0.001$). The correlation coefficient between WHR and PEFR was $r = -0.074$ which is not statistically significant ($p = 0.31$). Conclusion: PEFR was found to be significantly influenced by BMI, irrespective of the type of body fat deposition. Thus, the study concluded that there is a reduction in the lung volumes as the BMI increased.

Keywords: *Obesity, Peak Expiratory Flow Rate, Body Mass Index, Waist Hip Ratio.*

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Introduction

Pulmonary functions are determined by the strength of the respiratory muscle, thoracic cavity compliance, airway resistance and elastic recoil of the lungs.[1] Pulmonary functions vary according to the physical characteristics including age, gender, height, body weight[2] and altitude.[3] Different expiratory flow rates are employed for demonstrating the narrowing of airways.

Peak Expiratory Flow Rate (PEFR) is the maximum rate of airflow achieved during a forced expiration after maximal inspiration.[4] Hadorn introduced PEFR in 1942 and it was accepted as a parameter of pulmonary function test (PFT) in 1949.[5] Peak Flow Meter is an easy and cost effective instrument by which PEFR can be measured.[6] Impairments in lung function can be caused due to accumulation of excess body fat (obesity). Obesity can be defined as a state of excess adipose tissue mass.[7] Obesity increases morbidity and mortality due to many chronic health ailments, such as cardiovascular disease, type 2 diabetes, dyslipidemia and fatty liver disease.[8] Obesity also affects diaphragm, thoracic and abdominal muscles. Altered pulmonary functions arise due to increased respiratory effort and impairment of gas transport system.[9]

Body Mass Index (BMI) is significantly associated with body fat. It is also known as the Quetelet index and is defined as weight in kilograms divided by the square of the height measurement in metres (kg/m^2), and is commonly used as a practical means to assess body fat.[10] Obesity (in adults) is defined by WHO as having a BMI greater than or equal to 30kg/m^2; the normal BMI range being between 18.5 to 24.99.[11]Internationally, a BMI over 25 kg/m^2 is considered overweight. Due to genetic tendency of Indians towards abdominal obesity and its associated risk of diseases like diabetes and heart diseases, guidelines for diagnosis of obesity for India are: Normal BMI: 18.0 – 22.9 kg/m^2, Overweight BMI: 23.0 – 24.9 kg/m^2, Obesity: >25 kg/m^2.[12]Weight and BMI as measures of overall obesity are used as predictors of pulmonary function in many epidemiological studies.[13,14,15] BMI is not an ideal measure for excess body weight as of pulmonary function compared with Waist Circumference (WC)[16]. Waist Hip Ratio (WHR)[17] and Waist Circumference (WC)[18,19] often used as a surrogate measure for abdominal or upper body obesity may influence pulmonary function mechanically[20] by changes in compliance, work of breathing and the elastic recoil.[21,22] Therefore, markers of obesity, such as BMI,[23] WC[24] and WHR[25] may be correlated to PEFR. The aim of this study was to correlate the effects of obesity on pulmonary functions.

Materials and Method

Informed consent was obtained from each subject after explaining the study and test procedure. Demographic data was collected and recorded.

Materials Required:

- Wright's Portable Peak Flow Meter.
- Measuring tape.
- Weighing scale.
- Stationery

Sample and sampling technique:

Sample Size: 45 samples calculated from prevalence studies.

Sample Size Calculation: $\alpha = 0.05$ (type- I error), $d = 10\% = 0.1$ (anticipated error), $p = 0.126$ (prevalence), $q = 0.874$ (1-p)

$$n = \frac{Z^2_{\alpha/2} \times pq}{d^2}$$

Sampling Technique: Purposive sampling.

Inclusion Criteria:

- Subjects who were willing to participate in the study and signed the written informed consent.
- Subjects belonging to the age group of 20 to 40 years.
- Subjects must be females.
- BMI over 25kg/m^2 and WHR above 0.85.

Exclusion Criteria:

- Subjects with history of smoking.
- Subjects with severe chest trauma.
- Subjects with obvious chest and spinal deformity.
- Subjects with personal history of asthma, chronic obstructive pulmonary diseases and other cardiorespiratory diseases.
- Subjects who were physically active and into fitness training under supervision.

Procedure:

Anthropometric Measurements: Height was recorded without shoes in meters (m) and weight was recorded without shoes and light clothes in kilograms (kgs) to calculate the BMI.[26] BMI = Weight (in kgs) / Height (in squared meters).

Waist Circumference (WC) was measured with measuring tape with the subject's feet 25-30 cm apart between the lowest rib bone and the iliac crest[27] i.e. at the level of the umbilicus (more than or equal to 80 cm in females were defined as abdominal obesity using World Health Organization Asia Pacific prospective guidelines).[28]

Waist-to-Hip Ratio (WHR) was calculated as Waist Circumference (WC) divided by hip circumference (HC).[29] The WHO states that abdominal obesity is defined as a WHR above 0.85 for females.

PEFR Procedure: After the above values have been recorded, the subjects were instructed to have a light breakfast and refrain from beverages like coffee or tea on the morning of the test. The test was performed after 1-2 hours following breakfast.

The subjects were asked to perform the test in standing position, with the peak flow meter held horizontally in front of their mouth and were allowed to take a deep breath in, and close the lips firmly around the mouthpiece, making sure that no air leaks around the lips. The subject was asked to breathe out as hard and as fast as possible.

One or two trials were given prior to the actual procedure. This manoeuvre was repeated 3 times with a rest of 5 minutes between each. The best of the 3 readings was taken as final reading.[21]

Result

Data has been derived using descriptive and inferential statistics. SPSS16.0 was used. Data was expressed as Mean ± SD. Pearson's correlation coefficient test was done to see the correlation between BMI and PEFR and WHR and PEFR. The non- zero values of 'r' between -1 to 0 indicate negative correlation. The non- zero values of 'r' between 0 to +1 indicate positive correlation. Scatter diagrams have been plotted for the variables correlated.

Table 1: Age Distribution of the Subjects

Age	Frequency
20-25	11
26-30	10
31-35	12
36-40	12

Table 2: Mean & SD of Age, Weight, Height & BMI

Parameters	Age	Weight (Kgs)	Height (cms)	BMI (kg/m^2)
Mean	30.86	73.90	157.44	29.81
SD	6.17	12.64	7.08	4.52

Table 3: Mean and SD of WC, HC, WHR & PEFR

Parameters	Waist Circumference (cms)	Hip Circumference (cms)	WHR	PEFR (l/min)
Mean	100.02	111.22	0.89	290.33
SD	10.24	10.43	0.039	56.64

Table 4: Correlation between BMI and PEFR and WHR and PEFR.

Correlation Between	'r' Value	'P' Value
BMI and PEFR	-0.48377	p< 0.001
WHR and PEFR	-0.07425	p=0.31

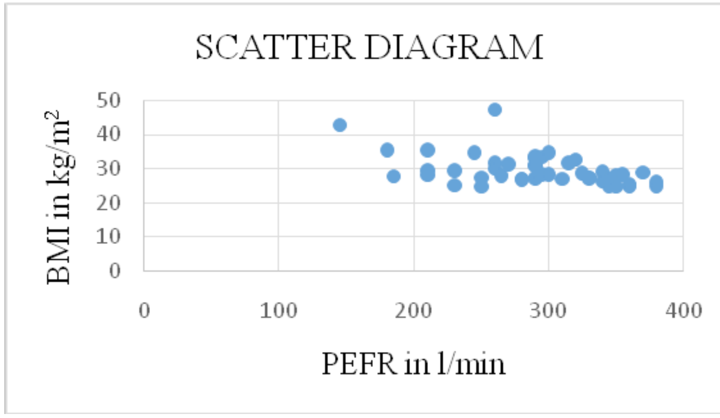

Fig. 1: Scatter diagram showing the correlation between BMI and PEFR in Young Adult Females.

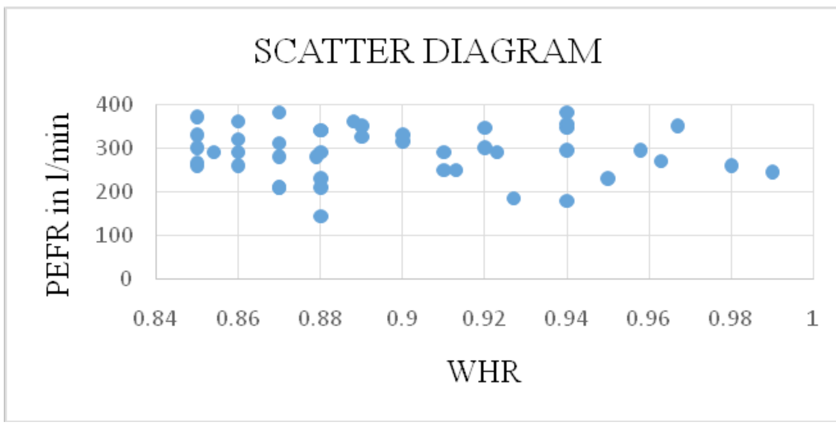

Fig. 2: Scatter diagram showing the correlation between whr and pefr in young adult females.

Discussion

The present study was conducted to find out the effects of obesity on Peak Expiratory Flow Rate (PEFR) in young adult females between the age group of 20-40 years. Body Mass Index (BMI) and Waist-to-hip Ratio (WHR) were taken as the markers of obesity. A total of 45 subjects were recruited into the study. Obesity criteria was taken based on Body Mass Index (BMI) and Waist-to-Hip Ratio (WHR).

The results of the present study showed a significant correlation between BMI and PEFR in young adult obese females. The primary factors that affect PEFR are the strength of the expiratory muscles producing the contraction, the recoil pressure of the lungs and the airway competency. According to Naimark A et al. the compliance of the lung and thoracic cavity was reduced to one third of the normal lung compliance due to obesity induced increase in pulmonary blood volume and closure of dependent airways.[1] Jones et al also found that the reduction in PEFR is proportional to the increase in BMI.[2] King GG et al observed a strong relationship between body mass index and both lung volume and airway calibre in obese individuals which reflects that, with increasing body mass index, airways were narrower than expected on the basis of the reduction in lung volume, suggesting thatthere were structural or functional changes in the airways.[3] The current study also found that there is a negative but not significant correlation between WHR and PEFR. Lazarus et al observed no effect of the central pattern of fat distribution (WHR) in the mean age 35.2±1.3 years, whereas subscapular skin fold thickness may have been significantly associated with spirometric measures after adjustment for overall obesity.[4] Lazarus et al and Collins et al also did not find any correlation between WHR and PEFR.[5] However, Yogesh Saxena et al found that abdominal adiposity, measured as WHR, is a better predictor of expiratory flow than weight or BMI.[6]

Conclusion

The results of the present study showed a significant correlation between BMI and PEFR in young adult obese females. The primary factors that affect PEFR are the strength of the expiratory muscles producing the contraction, the recoil pressure of the lungs and the airway competency. According to Naimark A et al., the compliance of the lung and thoracic cavity was reduced to one third of the normal lung compliance due to obesityinduced increase in pulmonary blood volume and closure of dependent airways.[3]

King GG et al observed a strong relationship between body mass index and both lung volume and airway calibre in obese individuals which reflects that, with increasing body mass index, airways were narrower than expected on the basis of the reduction in lung volume, suggesting that there were structural or functional changes in the airways.[22]A study conducted by Anuradha r. Joshi found that in males, the body fat % showed negative correlation with expiratory reserve volume (ERV), forced vital capacity (FVC), maximum ventilatory volume (MVV), peak expiratory flow rate (PEFR) and forced expiratory volume at the end of first second (FEV1). They also observed that in females, body fat % had negative correlation with ERV, FVC, and MVV[26]. This could explain the insignificant relationship between WHR and PEFR found in this study.

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The study concluded that there is a significant negative correlation between BMI and PEFR in young adult females. Although the correlation between WHR and PEFR is not significant.

LIMITATIONS: Larger sample size could have yielded better results and better understanding. Classification of the subjects based on the physical activity levels was not included. FURTHER RECOMMENDATIONS: An interventional study to find out if the effects of obesity on PEFR are reversible or not.

Conflict of Interest: There was no personal or institutional conflict of interest for this study.

Source of Funding: Self.

Ethical Clearance: Ethical clearance taken from R.V. College of Physiotherapy, Bengaluru

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