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ORIGINAL RESEARCH

Correlation of Peak Expiratory Flow Rate with Body Mass Index, Waist Circumference and Waist-Hip Ratio among healthy male in the age group of 18 – 25 years

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ABSTRACT

Background: Obesity is one of the most prevalent nutritional disorders globally, affecting nearly every body system, including pulmonary functions. Body Mass Index (BMI) is the most commonly used parameter to determine and classify obesity. However, Waist Circumference (WC) and Waist-to-Hip Ratio (WHR) are also important measures, particularly for identifying central obesity. **Aim:** To determine the effect of obesity on Peak Expiratory Flow Rate (PEFR) and to examine its correlation with these three obesity parameters. **Material and Methods:** A cross-sectional study was conducted to assess the impact of BMI, WC, and WHR on PEFR among 100 male participants aged 18-25 years. The study also aimed to evaluate the correlation between PEFR and these parameters of obesity. **Results:** Among the 100 male participants, 77 had normal BMI, 13 were classified as overweight, and 10 were classified as obese. The observed PEFR (L/min) values were 484.04±13.80 in the normal group, 477.23±11.70 in the overweight group, and 464.94±16.96 in the obese group. Significant differences were found between the normal and obese groups, as well as between the overweight and obese groups. Based on WC and WHR, the prevalence of obesity was 27% and 32%, respectively, with statistically significant reductions in PEFR among obese individuals using both measures. A negative correlation between PEFR and all three parameters (BMI, WC, and WHR) was also observed.**Conclusion:**Obesity has a detrimental effect on PEFR. While BMI exerts the strongest influence on PEFR, indicating the impact of total body fat, abdominal obesity (measured by WC and WHR) is also an important factor affecting respiratory health.

Keywords: Body Mass Index (BMI), Waist Circumference (WC), Waist-to-Hip Ratio (WHR), Peak Expiratory Flow Rate (PEFR)

INTRODUCTION

Obesity is perhaps the most prevalent form of Nutritional disorder, especially in developed and developing countries. As a chronic disease, with a high global prevalence, effecting adults as well as in Children. While, Obesity has a multifactorial origin, it effects almost all the systems of the body.[1] Obesity is influenced by height, race, ethnicity, and fat distribution, and is assessed using Body Mass Index (BMI), Waist Circumference (WC) and Waist-Hip Ratio (WHR).[2]

BMI is a simple index of weight relative to height, calculated as body weight in kilograms divided by height in meters squared (kg/m²). Although not a highly sensitive measure of body fat and its distribution, it is widely used in epidemiological studies to classify obesity and overweight due to its ease of measurement and reproducibility. Additionally, BMI is independent of age and sex variations within a specific race or ethnic group. [3,4]
Waist Circumference helps assess abdominal fat, which is a significant risk factor for various health

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conditions, including cardiovascular disease. A larger waist circumference can indicate higher levels of visceral fat. Waist-Hip Ratio is calculated by dividing the waist circumference by the hip circumference. It provides insight into fat distribution and is associated with health risks related to obesity. A higher WHR indicates a higher proportion of abdominal fat, which is often linked to increased health risks.[2]

Peak Expiratory Flow Rate (PEFR) is defined as, "The largest expiratory flow rate achieved with a maximally forced effort from a position of maximal inspiration, expressed in Litres/min." [5] It is an effort-dependent measure of the larger airways, which are particularly susceptible to dynamic compression in the extra-pulmonary airways.This vulnerability arises because, although these airways are influenced by pleural pressure, their walls lack the supportive traction provided by lung tissue. [6,7]

It has been seen that central obesity is more prevalent in south-east Asian region, and increased waist circumference is considered a better indicator in this region than BMI and WHR.[8] Therefore, this study is aimed at comparing the effect of BMI, WC and WHR on PEFR among voluntary male young adults in the age group of 18 – 25 years.

MATERIALS AND METHODS

The study was conducted among 100 healthy Voluntary males in the age group of 18 to 25 years. Informed written consent was taken before including the subjects in the study based on the following inclusion and exclusion criteria.

Inclusion Criteria

1. Healthy young male individual in the age group of 18 – 25 years

Exclusion criteria

1. Subjects with known respiratory diseases like Bronchial Asthma, Bronchitis, Tuberculosis, Emphysema etc.
2. Subjects with any known cardiovascular disease.
3. Subject with history of smoking.
4. Subjects with contra indication for Pulmonary Function Test (PFT). [9]

Weight was recorded without shoes and with light cloths on a bathroom type of weighing machine with a least count of 500 grams. Instrument was standardized prior to the study. Height was measured without shoes and subject standing against a wall on which a measuring scale was placed. The subject has to stand erect, feet parallel and heels, buttocks, shoulder and occiput touching the vertical rod of the anthropometer. Head held erect, eyes aligned horizontally and ears vertically without any tilt. The horizontal bar which is at right angle to the vertical rod was placed touching the vertex. Height was measured to the nearest of 0.5 cm. Waist circumference measurement was done with minimal, adequate clothing (light cloths) with feet 25–30 cm apart and weight equally balanced, with a measuring tape in a plane perpendicular to the long body axis at the level of umbilicus without compression of the skin with value nearest to 0.5 cm. Hip circumference measurement was done with minimal, adequate clothing (light cloths) across the greater trochanter with legs and feet together by a measuring tape without compressing the skin fold with value nearest to 0.5 cm.

From weight and height BMI (weight in Kg/Height in meter^2) was calculated. Similarly, waist-Hip Ratio (WHR) was also calculated from waist circumference and hip circumference.

PEFR was measured in standing position using Medspiror, which is an electronic spirometer. Subject has to close his/her nose with a nose clip and then have to blow into the mouth piece placed just inside the mouth soon after the deep inhalation. The lips should be sealed tightly around the mouthpiece to prevent air leakage. Subject was asked to blow as forcibly and as fast he can. Before doing the procedure, procedure was explained and a practical demonstration was given. Three readings were taken at an interval of 1 – 2 minute and highest of the three readings were recorded. After reading was taken for each individual, disposable mouth piece was changed and instrument was disinfected with rectified spirit.

All the data were coded and compiled in MS Office Excel 2021 and further relevant statistical analysis were done.

RESULTS

The mean age of the study population was 21.17±2.21 years. WHO Classification for obesity based on BMI was used to classify the study population into Under weighr (BMI <18.5), normal (BMI 18.5–24.9), Overweight (BMI 25–29.9) and Obese (BMI ≥30). [10,11]. In our study population of 100 male participants 77 had Normal BMI, 13 were overweight and 10 were obese. We found no underweight subject. In table:1 PEFR in different BMI groups are shown. We found significant difference of PEFR between individuals with normal BMI and those who are obese (P=0.00013) as well as between overweight and obese individuals (p=0.05217). however, there is no significant difference of PEFR between normal and overweight individuals (P=0.09677). In Figure-1 we have shown the negative correlation between BMI and PEFR (r= -0.48476).

Table 1: PEFR (Lit/min) in different BMI groups

BMI Group	Normal (18.5 – 24.9)	Overweight(25 – 29.9)	Obese (≥ 30)
Observations	77	13	10
Mean	484.04	477.23	464.94
SD	13.80	11.70	16.96

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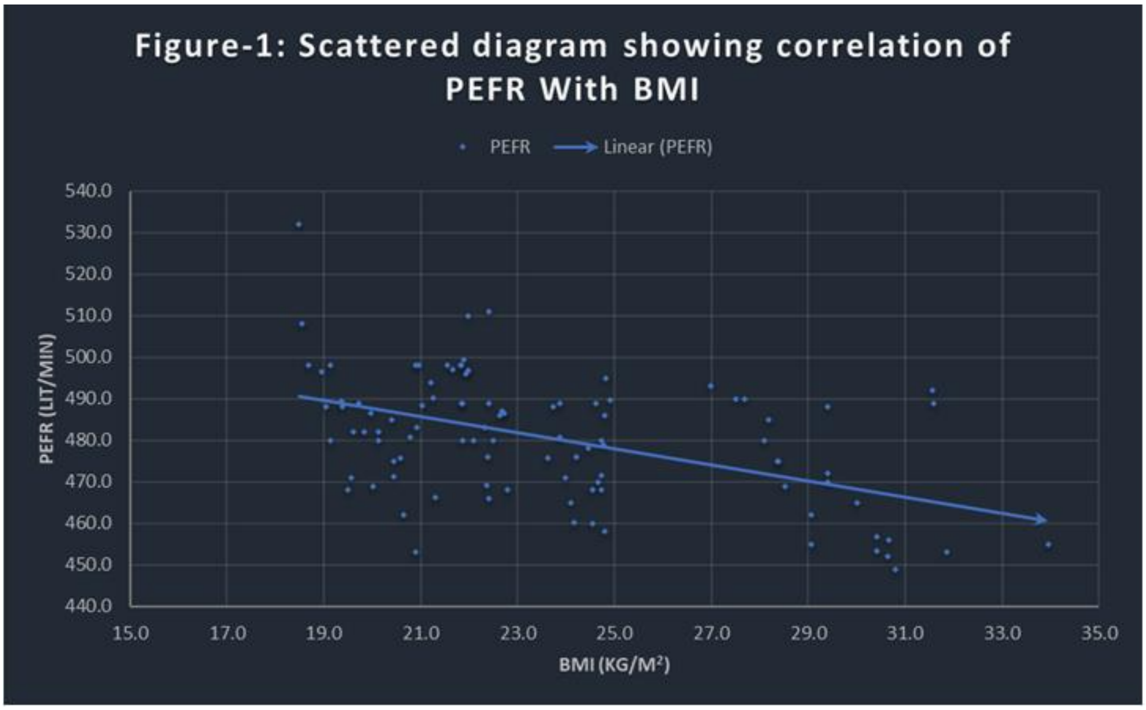

In our study while, classifying obesity based on waist circumference, with <90 cm used as the cutoff value for obesity in males, it was found that 27% of participants were classified as obese. [10,12] A significant difference was observed in Peak Expiratory Flow Rate (PEFR) between normal and obese individuals, with normal individuals having a PEFR of 483.86 ± 13.98 and obese individuals having a PEFR of 471.81 ± 14.53. The difference in PEFR was statistically significant (P = 0.00026). In Figure-2 the negative correlation (r=-0.45657) between Waist Circumference and PEFR is shown.

When Obesity was classified according to Waist-Hip Ratio with WHR <0.9 as cutoff value for obesity in male, we found 32% participants to be obese. [10, 12] A significant difference of PEFR between normal and obese individuals were observed, with normal and obese subjects having average PEFR of 484.15±14.32 and 473.07±13.92 respectively. We found a negative correlation (r= -0.40314) between Waist-Hip Ratio and PEFR which is shown in Figure-3.

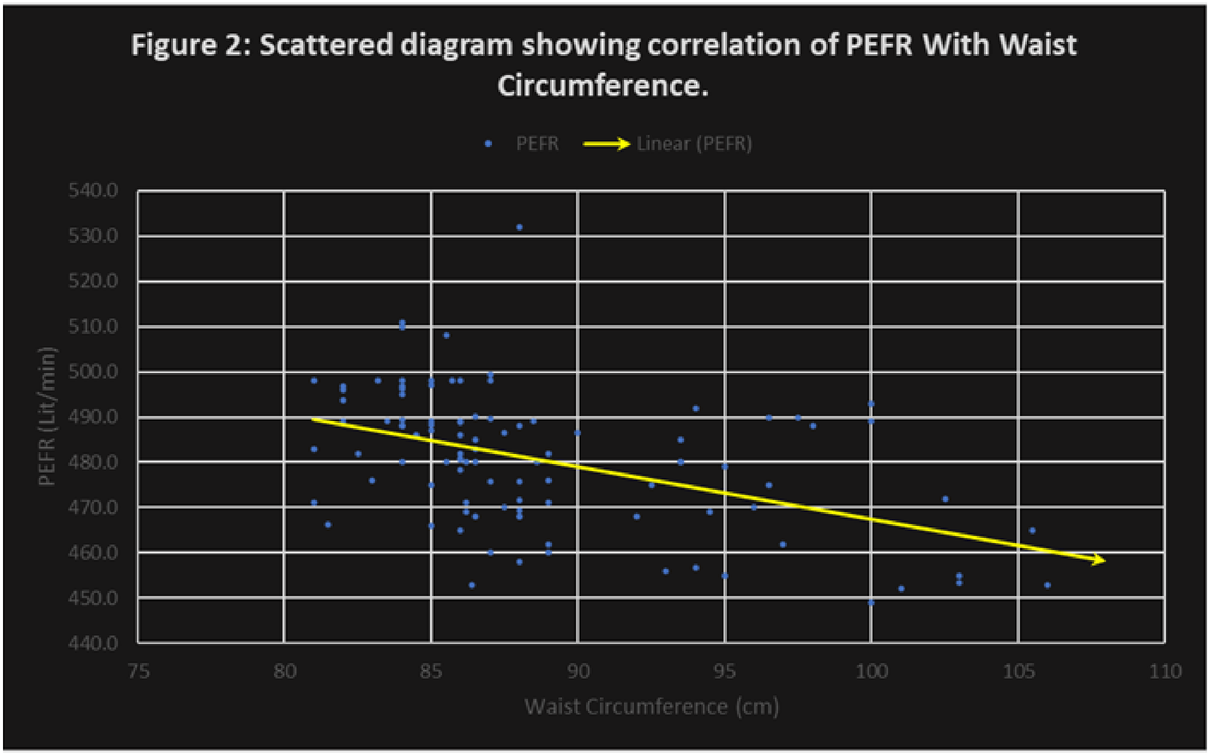

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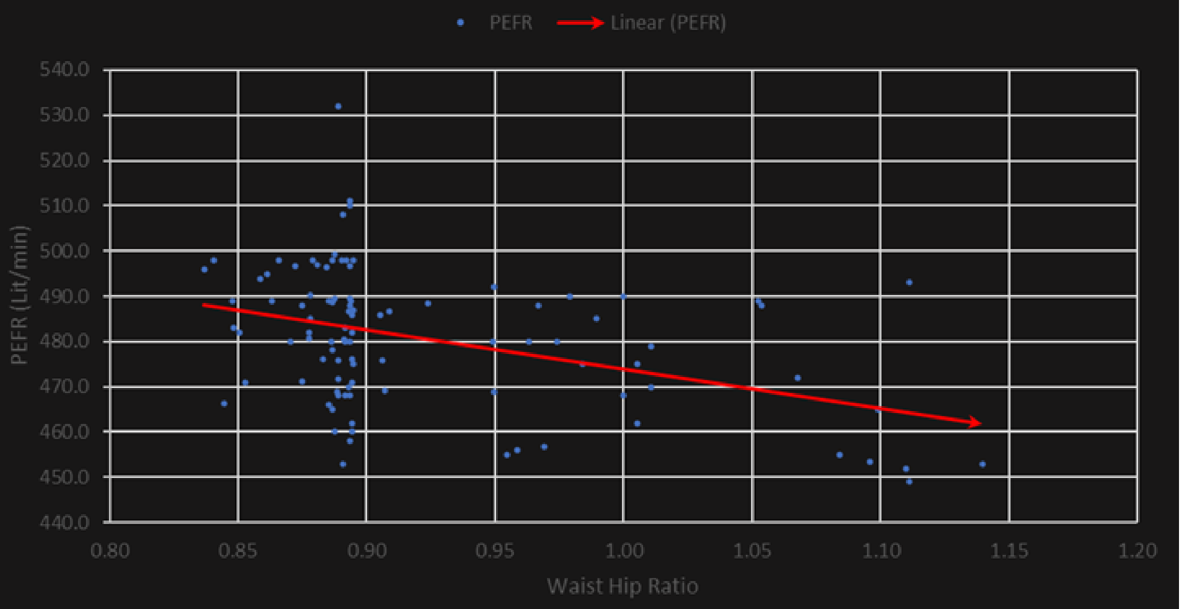
Figure 3: Scattered diagram showing correlation of PEFR With Waist Hip Ratio.



DISCUSSION

In our study, we found that the prevalence of overweight and obesity was 13% and 10%, respectively, indicating that a total of 23% of the study population was above the normal weight limit (BMI ≥ 25). Our results are slightly higher than the national average of 22.9%, as reported in the National Family Health Survey – 5 (NFHS-5, 2019-21). [12]

When we classified abdominal or central obesity based on Waist Circumference (with an upper cutoff value of < 90 cm for males) and Waist-Hip Ratio (with an upper cutoff value of < 0.9 for males), we found the prevalence of obesity to be 27% and 32%, respectively. These findings are lower than the national average of 47.7%.[12] The lower prevalence of central obesity in our study may be attributed to the younger age group (18-25 years) of our study population, compared to the broader age range (15-49 years) reported in the NFHS-5.

We found a significant decrease in PEFR between normal and obese groups, as well as between overweight and obese groups. Although the PEFR was lower among overweight individuals, the difference was not statistically significant. Similar findings have been reported by Kharodi et al. and Mankar et al., who observed a decrease in PEFR across different BMI categories [13,14]. Furthermore, we observed a statistically significant reduction in PEFR among obese individuals compared to the normal group when obesity was classified based on central obesity parameters, such as waist circumference and waist-to-hip ratio. Rai et al. also reported a similar decrease in PEFR among male participants [15].

We found a negative correlation between PEFR (Peak Expiratory Flow Rate) and all three parameters of obesity: BMI, waist circumference, and waist-to-hip ratio. The negative association was strongest with BMI (r = -0.48476), followed by waist circumference (r = -0.45657), and waist-to-hip ratio (r = -0.40314). The stronger negative correlation between PEFR and waist circumference compared to waist-to-hip ratio may be attributed to waist circumference being a more accurate indicator of central adiposity than waist-to-hip ratio.[16]

The decrease in PEFR in obese individuals may be attributed to fat accumulation around the ribs, abdomen, and diaphragm, which restricts rib movement, reduces lung volume, and lowers respiratory compliance.Increased body fat is linked to higher levels of inflammatory cytokines like interleukin-6 and tumour necrosis factor-alpha, along with lower levels of the anti-inflammatory protein adiponectin. This imbalance heightens systemic inflammation throughout the body. As a result, lung function can be negatively impacted due to chronic inflammation. [17,18]

CONCLUSION

The pulmonary function parameter, Peak Expiratory Flow Rate, is negatively impacted by obesity, which can be measured through Body Mass Index, Waist Circumference, and Waist-Hip Ratio. Among these, BMI exerts the strongest negative influence on PEFR, indicating that overall body weight has the most significant effect on lung function. While both WC and WHR also show a negative correlation with PEFR, waist circumference (WC) has a more pronounced impact compared to WHR, suggesting that central obesity plays a key role in the reduction of pulmonary function. This emphasizes the importance

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of managing not only total body fat but also abdominal fat to maintain optimal respiratory health.

Conflict of Interest: There is no conflict of interest.

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