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Comparison of Peak Expiratory Flow Rate (PEFR) among Individuals with Pear Shape and Apple Shape Obesity

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Abstract
Obesity, characterized by excessive adipose tissue growth, varies not only in fat quantity but also in regional distribution, influencing associated health risks. The two common fat distribution patterns—apple (android) and pear (gynoid) shapes—differ in fat accumulation sites and may differently impact respiratory function. Obesity adversely affects pulmonary mechanics by increasing respiratory effort, reducing lung compliance, and impairing gas exchange. Peak Expiratory Flow Rate (PEFR) is a simple, non-invasive measure reflecting airway function and is widely used to assess respiratory health. While obesity is known to reduce lung function, the specific effects of fat distribution on PEFR remain unclear. This study aims to compare PEFR values between individuals with apple-shaped and pear-shaped obesity to understand how fat distribution influences airway performance. Understanding these differences can help tailor interventions and improve respiratory health outcomes in obese populations.

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Keywords: Obesity, Fat distribution, Apple-shaped obesity, Pear-shaped obesity, Peak expiratory flow rate (PEFR)

Introduction

Obesity may be defined as an abnormal growth of the adipose tissue due to an enlargement of fat cell size or an increase in fat cell number or a combination of both. Obese individuals differ not only in the amount of excess fat that they store, but also in the regional distribution of the fat within the body. The distribution of fat induced by the weight gain affects the risk associated with obesity, and the kind of disease that results.

Overweight and obesity are the fifth leading risk of global deaths. Worldwide, obesity has more than doubled since 1980. In 2008, more than 1.4 billion adults, 20 years and older, were overweight. Of these over 200 million men and nearly 300 million women were obese [1]. Once considered a high-income country problem, overweight and obesity are now rising in low-and middle-income countries, particularly in urban settings. In addition, it is associated with future risk of increased breathing difficulties, increased risk of fractures, hypertension, early markers of cardiovascular disease, insulin resistance and psychological effects. At least 3.4 million adults die each year because of being overweight or obese. In addition, 44 per cent of the diabetes burden, 23 per cent of ischaemic heart disease burden and between 7 to 41 per cent of certain cancer burdens are attributable to overweight and obesity. Overweight and obesity are linked to more deaths worldwide than underweight. In India, the non-communicable risk factor survey phase 2 was carried out in the year 2007-2008, in the states of Andhra Pradesh, Kerala, Madhya Pradesh, Maharashtra, Tamil Nadu, Uttarakhand and Mizoram. The survey shows high prevalence of overweight in all age groups except in 15-24 years group. Overweight prevalence was higher among females than males and in urban areas than in rural areas. In India, 1.3 per cent males and 2.5 per cent females aged more than 20 years were obese in the year 2008 [2].

Obesity also affects diaphragm, thoracic and abdominal muscles.

Altered pulmonary functions arise due to increased respiratory effort and impairment of gas transport system [3]. The major respiratory complications of obesity include increased demand for ventilation, elevated work of breathing, respiratory muscle inefficiency and reduced respiratory compliance. This reduction in respiratory and chest wall compliance causes an increase in respiratory resistance [4].

The "apple" body shape is known as "android," meaning that most of the fat is stored in the midsection and less fat is stored in the hips, buttocks, and thighs. People with android body types tend to have a larger waist-to-hip ratio, meaning their waist is larger or close to equivalent in circumference to their hips. The "pear" body shape is known as "gynoid," which means more fat is stored in the hips, buttocks, and thighs than in the midsection. People with gynoid body types often have a smaller waist-to-hip ratio, which means their hips are usually wider than their waist.

The various method to measure obesity are BMI, Waist circumference, Waist-to-hip ratio, Skinfold thicknesses, Bioelectrical impedance etc. Body mass index (BMI) is a simple index of weight for height that is commonly used to classify underweight, overweight and obesity in adults. It is defined as the weight in kilograms divided by the square of the height in metres (kg/m2) [5]. WHR is used as a measurement of obesity, which in turn is a possible indicator of other more serious health conditions. The WHO states that abdominal obesity is defined as a waist-hip ratio above 0.90 for males and above 0.85 for females or a body mass index (BMI) above 30.0 [6]. Waist circumference is a convenient and simple measurement that is unrelated to height, correlates closely with BMI and WHR and is an approximate index of intra-abdominal fat mass and total body fat. Waist circumference is measured at the level of umbilicus. Hip circumference is recorded at the widest point over the greater trochanters, and waist-to-hip ratio was calculated. The National Heart, Lung, and Blood Institute (NHLBI) classify the risk of obesity-related diseases as high if men have a waist circumference greater than 102 cm (40 in) and women have a waist circumference greater than 88 cm (35 in). Waist-to-hip ratio is a better predictor of a person's future health issue than BMI. It has long been recognized that body mass index is a predictor of the morbidity and mortality that are due to numerous chronic disease, including type 2 diabetes, cardiovascular disease and stroke [7, 8]. In addition, it has been established that abdominal obesity, assessed by waist circumference, predicts obesity-related health risk [7, 8, 9, 10] and the weighted evidence indicates that waist circumference coupled with BMI predicts health risk better than does BMI alone [9, 11, 12, 13]. Also a person with lots of muscle and minimal body fat can have the same BMI as a person with obesity who has much less muscle. BMI also varies among people of different ages and whether they are active or sedentary. That means it can be misleading in some cases.

Peak expiratory flow rate (PEFR) is a key parameter in pulmonary function testing, reflecting the maximum airflow achieved during a forceful expiration [14]. It serves as a valuable indicator of airway obstruction and is widely used in the management of respiratory conditions such as asthma and chronic obstructive pulmonary disease (COPD). PEFR measurement is integral for diagnosing, monitoring, and assessing the severity of respiratory diseases, as well as evaluating the response to therapeutic interventions [15]. Traditionally, peak flow meters have been employed as a cost-effective and portable tool for PEFR measurement.[16]

The peak flow meter is a useful instrument for monitoring PEFR in children and adults. It can be used to measure Peak Expiratory Flow Rate (PEFR) value and is an easy tool to assess lung function in field studies. PEFR value can be measured by Wright's mini-Peak flow meter, which is a small, portable, convenient and inexpensive device. Hadorn introduced PEFR in 1942 and it was accepted as a parameter of pulmonary function test (PFT) in 1949 [17]. Peak Flow Meter is an easy and cost effective instrument by which PEFR can be measured [18].

In both men and women, height, weight, handgrip strength, and residence in the rural were positively associated with PEF significantly. Age and smoking status were negatively associated with PEF significantly. The normal range of PEFR in male lies between 450-700 Liters/ min and females have lower range between 300-500 Liters/min. [19] PEFR values vary with various factors like age, sex, body surface area, obesity posture, physical activity and also the environment. The primary factors that affect PEFR are the strength of the expiratory muscles generating the force of contraction, the elastic recoil pressure of the lungs and the airway size [20]. Peak expiratory flow (PEFR) helps to assess the airflow limitation through the airways and thus, help to determine the degree of obstruction and to measure the lung functions.

Need of study

Obesity can affect lung function, but the influence of fat distribution particularly apple shaped obesity and pear shaped obesity on airway performance is still under research. It is necessary to know the impact of obesity on respiratory parameters using a simple non-invasive test. Peak Expiratory Flow Rate (PEFR) demonstrates the severity of the respiratory diseases and is accepted worldwide as the objective indicator of obstructive lung disease. It is still not clear whether difference in fat distribution will have different effect on PEFR. There are very few researches available which shows the impact of fat distribution on PEFR. So this study will be undertaken to compare the PEFR in apple shape and pear shape obesity.

Aim

To compare peak expiratory flow rates among individuals with pear shape and apple shape obesity

Objectives

- To find out peak expiratory flow rate in individuals with Apple shape obesity.
- To find out peak expiratory flow rate in individuals with Pear shape obesity.
- To compare peak expiratory flow rate in individuals with apple and Pear shape obesity.

Review of literature

1. Hardikkumar A Mistry, Narendra Pathak (2023)- Conducted study on Study of peak expiratory flow rate in male and female young adults with respect to their weight status 40 subjects between the age group of 18 to 25 years were recruited for the study. The groups were divided according to BMI values, underweight (30). Data were taken and calculated 2 h post lunch after relaxing for 15 min in the afternoon. In the sitting position, at the same time of the day, PEFR values were measured using Wright's Peak Flow Meter. They found

significantly high PEFR values in males as compare to females in the category of underweight (<0.01), normal (<0.05) and overweight (<0.05). The study also shows positive correlation between BMI and PEFR in underweight male and females, normal males, overweight females, and obese females, which is statistically non-significant, except in obese males. The study concluded that male have high PEFR values than female as there are differences in their body build-up and low PEFR values in underweight and obese young adults as they have low body fat and reduced expansion of lungs, respectively.

2. Shanmugapriya Chinnaiyan, Vinodha Ramayyan (2021)- Conducted a study on Comparison of Peak Expiratory Flow Rates (PEFR) between obese and non-obese Females: 40 healthy obese females with BMI ≥30Kg/m2 and 40 healthy non-obese females with BMI (18.5–24.9 Kg/m2) as controls were included in the study. PEFR Measurements were performed using a Mini Wright's Peak Flow Meter. Three readings at 2 minutes intervals were recorded. The maximum of the 3 values were taken as the PEFR. The results were statistically analysed using Students Unpaired t- test. PEFR in obese females (320±28.06 L/Min) was significantly lower than the non-obese females (361±29.17L/Min), which was statistically significant (p=0.000; p<0.05). PEFR was negatively correlated with BMI (Pearson's correlation r = -.127) significant at p<0.01 level.
3. Shruti Shah, Pratibha Gaikwad(2021) – Conducted study on comparison of peak expiratory flow rate between android and gynoid pattern obesity in female. 100 Female Obese Subjects with BMI> 30 in the Age Group between 20-40 yrs living a sedentary lifestyle were recruited with incidental sampling over the period of 1 year duration and allocated to Android (n = 50) and Gynoid (n = 50) groups on the basis of Adiposity Markers like BMI, Height, Weight, Waist Circumference (WC), Hip Circumference (HC), WHR - Waist Hip Ratio (WHR) and Waist to Height Ratio (WtHR). PEFR was recorded by taking 3 readings and the highest among them chosen. Pearson correlation test and Linear Regression was done between PEFR & BMI, PEFR & WHR and PEFR & WHtR. Using an Unrelated t Test, results were found to be Significant (p < 0.05) between PEFR in Both the Groups. The study establishes that there is a difference in PEFR between Android and Gynoid Pattern of Obesity in Females and PEFR in Gynoid Pattern is 5% better than PEFR in the Android Pattern Obesity in Females.
4. Rudalee Husale, Dr. Abhijit Diwate (PhD), Dr. Arijit Das (2019)- Conducted a study on Effects of Obesity on PEFR values: The study design was Observational. The study was conducted at Dr. Vithalrao Vikhe Patil Memorial Hospital Ahmednagar. The total duration of the study was 6 Months. The sampling method used was purposive sampling. Total no. of sample size 30. Those patients satisfying the inclusion criteria with the age group of 18-25 years and BMI≥25and less than ≤34.9 (Obese) were included for the study. The results were ana-lyzed by using the Spearman Rank correlation test, where the Statistical not significance was set at p>0.05. The study shows no correlation between the body mass index and PEFR in obese students using the Spearman Rank correlation test, p-value obtained was 0.1766, which is statistically not significant To determine the correlation between PEFR Value in obese Students. Thereby concluding that no effect of PEFR value in obese students. It also showed no Correlation between the body mass index and PEFR in obese students.
5. Pavana, Bhavya Shree P. (2014) - Conducted study on Correlation of Obesity and Peak Expiratory Flow Rate in Young Adult Females 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. 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. The correlation coefficient between WHR and PEFR was r = -0.074 which is not statistically significant (p = 0.31). 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.

Methodology

Study design: Cross sectional study.
Study population: Obese individuals.
Sampling technique: Convenient sampling.
Sample size: 52

$$n = 2\frac{S^2(Z1 + Z2)^2}{(M1 - M2)^2}$$

M1	Mean test intervention	93.44
M2	Mean control intervention	86.22
S1	Standard deviation of M1	10.31
S2	Standard deviation of M2	6.99
S	Pooled SD	8.80
1-α	level of confidence = 0.95	0.95
1-β	Level of power of test	0.90
Z1	Z value associated with alpha	1.64
Z2	Z value associated with beta	1.28
N1	**Minimum sample size Group 1**	**26**
N2	**Minimum sample size Group 2**	**26**

Study duration:6 months.
Place of study: Physiotherapy OPD, a tertiary care multi-speciality hospital, Jalgaon

Materials

- Pen
- Weighing Scale
- Height Scale
- Inch tape
- Assessment sheet
- Peak Flow Meter

Outcome Measures

- **Peak flow meter**

A Peak flow meter is a portable device used to measure the Peak Expiratory Flow Rate.

It is simple to handle.
Usually used in standing and sitting position.
Normal values for Male:- 450 – 700L/min
Female:- 300 – 500L/min

Fig 1

Selection Criteria

Inclusion criteria:

- Individuals with BMI > 24.9
- Waist-to-hip ratio (male >0.90, women >0.85 for apple shape), (women <0.85 for pear shape).
- Waist Circumference (male >94cm, women >88)
- Hip Circumference (male >105cm, women >108)
- Both Males and females
- Subjects who are willing to participate.
- Individuals with age 18-35 years

Exclusion criteria

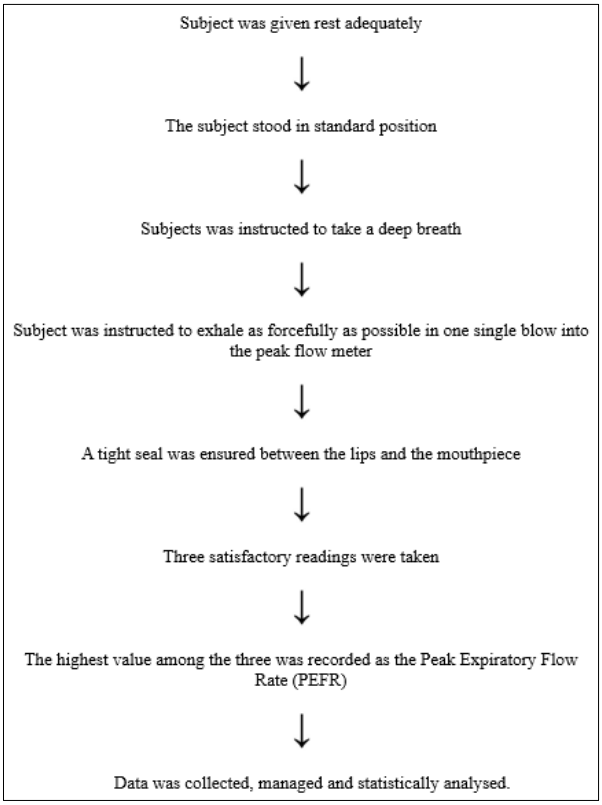
- Subjects with any trauma
- Any spinal deformity
- Subject with any musculoskeletal/ cardiovascular/ respiratory/ neurological/ metabolic diseases and or disorder
- Subject with known case of any pollen Allergy or Systemic infections
- History of any recent abdominal, thoracic, cardiovascular surgeries or fracture
- Subjects participating in any type of exercise

Procedure

To conduct the following study, approval was taken from Institutional Ethics Committee (IEC) of Dr. Ulhas Patil Collage of Physiotherapy, Jalgaon Subjects were included according to the inclusion and exclusion criteria. Prior to starting the study, the procedure was explained and informed written consent form were taken from the subjects. Then the subjects were evaluated for obesity using BMI and waist-to-hip ratio and their type of obesity is noted eg. Either apple shape or pear shape. Height (H) was measured to the nearest 0.5 cm with the help of a height scale [21]. Weight (W) was measured by a weighing scale in kilograms without shoes, and with subjects wearing light weight clothes [21]. BMI was calculated using Quetelet's formula

(BMI = weight in kilograms / height in meter square) [21].

Waist Circumference (WC) was measured in erect posture with the feet apart by 25 to 30 cm on light clothing, using a measuring tape at the level of umbilicus [22].
Hip Circumference (HC) was measured at the widest part of the buttocks with the legs and feet together [21]. Waist Hip Ratio (WHR) was calculated by dividing WC by HC [21]. Then Peak Expiratory Flow Rate was recorded for participants using peak flow meter.
Peak Expiratory Flow Rate: Recorded using Wright's mini peak flow meter (Clement & Clarke, UK) in standing position. After adequate rest, subjects were instructed to take a deep breath and exhale as forcefully as possible in one single blow into the instrument. Three satisfactory readings were taken. Sufficient care was taken to ensure that a tight seal is maintained between the lips and mouthpiece. The highest among the three was considered as the Peak Expiratory Flow Rate[21].



Statistical Analysis

- The patient data and test result of subjects was entered in MS Excel sheet before it was statistically analysed.
- A total 52 male and female participants were included in this study.
- The data obtained from the participants was statistically analysed.
- Mean and standard deviations were calculated for all the needed variables

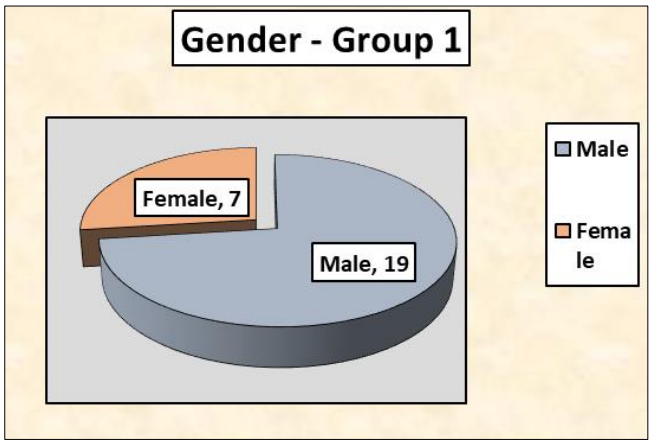
Results

Table 1: Mean and SD of Age in Apple and Pear shape

	Group	Mean (18-35 yrs)	SD (18-35yrs)	Min	Max
Age (18-35 yrs.)	Group 1 (Apple)	27.88	4.08	19	35
	Group 2 (Pear)	28.3	4.93	20	35

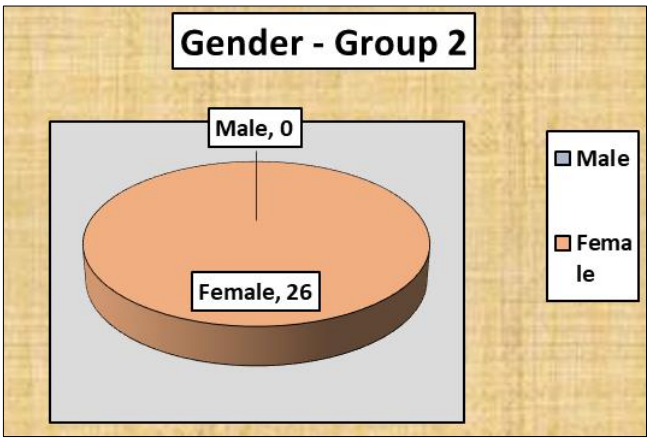
Table 2: Gender wise distribution of study subjects.

Sr. No.	Variable	Groups	Group 1 (Apple)		Group 2 (Pear)	
			Frequency	Percentage	Frequency	Percentage
2	Gender	Male	19	73.08	0	0.00
		Female	7	26.92	26	100.00



Graph 1

COMMENT – In group 1 which is apple shape obesity 73.08% subjects are males and 26.92% subjects are females.



Graph 2

COMMENT – In group 2 which is Pear shape obesity 100% subjects are females.

Table 3: PEFR wise distribution of study subjects.

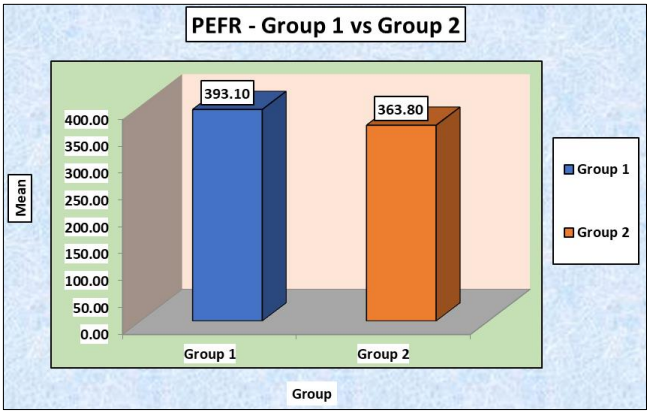
Sr. No.	Variable	Groups	Score	Group 1 (Apple)		Group 2 (Pear)	
				Frequency	Percentage	Frequency	Percentage
PEFR	Male	Normal	450-700L/min	2	7.69	0	0.00
		Reduced	below 450L/min	17	65.38	0	0.00
	Female	Normal	300-500L/min	0	0.00	25	96.15
		Reduced	below 300L/min	7	26.92	1	3.85

Comment – In group 1 (Apple shape obesity) 7.69% male subjects have normal PEFR value between the range of 450-550L/min and 65.38% male subjects have reduced PEFR value (i.e. below 450L/min). Whereas 26.92% female subjects have reduced PEFR value (i.e. below 320L/min)
In group 2 (Pear shape obesity) 96.15% female subjects have normal PEFR value between the range of 320-470L/min and 3.85% female subject have reduced PEFR (i.e. below 320L/min).

Table 4: Showing Comparison of PEFR in Apple shape and Pear shape obesity individuals.

Group	Frequency	Mean	S.D.	t value	P value
Group 1 (Apple)	26	393.10	65.30	2.07	0.046
Group 2 (Pear)	26	363.80	30.50		

The comparisons of average PEFR scores of group 1 and group 2 was done by unpaired t test. The group 1 average score was 393.10 with standard deviation of 65.30. The group 2 average score was 363.80 with standard deviation of 30.50. The test statistics value of unpaired t test was 2.07 with p value 0.046. The p value less than 0.05. That means there is significant difference in average PEFR of group 1 and group 2.



Graph 3

Discussion

- The present study was done in 52 subjects of both genders and aim of this study was to compare peak expiratory flow rates among individuals with pear shape and apple shape obesity.
- Among 52 subjects 26 were apple and 26 were pear shaped. When there PEFR was compared statistically using unpaired t-test, the p value obtained was 0.046 which is less than 0.05, this indicates that there is significant difference in the PEFR of both groups.

- The results found in this study are comparable and similar to the study done by Shruti Shah, Pratibha Gaikwad. They compared Peak Expiratory Flow Rate between Android and Gynoid Pattern Obesity in Females and they conclude that there is a correlation between PEFR and Android Obesity, PEFR and Gynoid Obesity and there is a difference in PEFR between Android and Gynoid Obesity in Females. The result was found to be significant ($p<0.05$). This means that there is a difference in Peak Expiratory Flow Rate between Android and Gynoid Obesity in Females. The PEFR in the Gynoid Group is 5.6% better than PEFR in the Android Group [23].
- Another study done by Pavana, Bhavya Shree P. correlated obesity and PEFR in Young Adult Females and the study showed a significant correlation between BMI and PEFR in young adult obese females. The results of this 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. Results found in this study are comparable and similar to our study [24] Correlation coefficient for BMI and PEFR was $r = -0.48$ and is statistically significant ($p< 0.001$). 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.
- One more study done by Shanmugapriya Chinnaiyan, Vinodha Ramayyan Das on Comparison of Peak Expiratory Flow Rates (PEFR) between obese and non-obese Females concluded that significant reduction in PEFR was noted in obese females compared to non-obese females. There occurs a significant reduction in PEFR in obese females, compared to non-obese females. PEFR in obese females was significantly lower than the non-obese females which was statistically significant ($p=0.000$; $p<0.05$). There occurs a significant reduction in PEFR in obese females, compared to non-obese females. This study highlights the need for aggressive reduction of weight in obese females in order to increase respiratory efficiency.
- Similar study was done with spirometric pulmonary test by Krina Chheda, Jaimala Shetye, Amita Mehta on Comparison of spirometric pulmonary function in subjects with apple and pear shape fat distribution. The FVC,%FEV1/FVC values between the two groups were compared and the results were non-significant. It is observed that pear shaped show better flow as compared to apple shape. It implies that apple shaped fat distribution among over weight and obese individuals have significantly more individuals showing obstructive pattern as compared to those with pear shaped fat distribution [25].
- It is well established that obesity decreases both lung and chest compliance and hence decreases the lung volumes and capacities. There is an increase in resistance to outflow of air in obesity [26] The pattern of pulmonary function worsens with the degree of obesity moving from a restrictive pattern in mild to moderate obesity with both FEV 1 and FVC reduced and%FEV1/FVC ratio being normal to an obstructive pattern in severe and morbid obesity with significant decrease in FEV 1 and%FEV1/FVC ratio being decreased [27].
- In apple shaped individuals, there is increased fat accumulation in the abdominal region. The central fat may compress the thoracic cavity and impede diaphragmatic mobility, resulting in a narrowing of the thoracic cavity's vertical dimension [28]. These alterations may cause the lungs and thoracic cavity to become less compliant, putting more strain on the breathing muscles. This may result in a decrease in lung volumes and flow rates, particularly PEFR [29].
- Pear shaped individuals which are characterized by deposition of fat in hip and thigh region have PEFR with normal range. Since fat accumulation may not exert the same restrictive effect on the diaphragm and lungs as central fat, lungs and thoracic cavity are largely unaffected.

Conclusion

Obesity reduces PEFR in apple shaped individuals but not so in pear shape shaped individuals. PEFR is lower in apple shaped individuals due to increased fat accumulation around the abdomen, which restricts diaphragmatic movement and lung expansion where as in pear shaped individuals demonstrated relatively better PEFR values as their fat distribution primarily affects the lower body.

Acknowledgement

I would like to thank Dr. JAYWANT NAGULKAR, Principal, Dr. Ulhas Patil College of Physiotherapy, Jalgaon, for allowing me to conduct study. I am highly grateful to Dr. AMIT JAISWAL, Associate Professor, Dr. Ulhas Patil College of Physiotherapy, Jalgaon, for his guidance, encouragement and support. I would like to thank, all my teachers for their immense support and guidance. I am thankful to all my subjects for their participation and co-operation

Future scope

- Study can be done with long term effects of fat distribution on lung function in both genders with other pulmonary function tests to better understand obesity-related respiratory limitations.
- Study can also be done to see does fat loss have any effect on PEFR.

Clinical Implications

People with apple- shaped obesity are at a higher risk of lung function impairment because abdominal fat restricts lung expansion so it is important to include weight management and breathing exercise.

Limitations

- PEFR was measured only once for each participants, which may not account for daily variations or external factors (such as fatigue, stress or environmental conditions) which could affect lung function.
- The study only focused on PEFR where as additional lung function tests like Forced Expiratory Volume in 1 sec (FEV1), Forced Vital capacity, and spirometry could provide better understanding of respiratory health in obese individuals.

Declaration

I hereby declare that the project entitled "Comparison of Peak Expiratory Flow Rate (PEFR) Among Individuals with Pear Shape and Apple Shape Obesity" will be performed by me under the guidance and suggestion received from Dr. Amit Jaiswal, Associate Professor, Dr. Ulhas Patil college of Physiotherapy, Jalgaon to the best of my knowledge. This will not be submitted in part or whole anywhere in any institution as project report.

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