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PEAK EXPIRATORY FLOW RATE (PEFR) AND BODY MASS INDEX (BMI) IN ADULT FEMALE: A SYSTEMATIC REVIEW

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ABSTRACT

The Peak Expiratory Flow Rate (PEFR) is the maximum or peak flow rate that is attained during a forceful expiratory effort after taking a deep inspiration. It is expressed in liters per minute. The average Peak Expiratory Flow Rate of healthy young Indian females is 350 Liters/minute. The Pulmonary function tests (PFTs) are non invasive tests which help to diagnose patients with obstructive and restrictive lung diseases. Individuals with obesity are more susceptible to many conditions such as obstructive sleep apnea, pulmonary, cardiovascular, hepatic, renal diseases, metabolic alterations, and neoplasm. More than 23% of women are either overweight or obese which are higher value than the prevalence amongs men. In most of the studies, Wright's Peak Flow meter is best for assessing lung functions as it is cheaper and is also found that there is negative correlation between Body Mass Index and Peak Expiatory Flow Rate. PEFR values are found to be lower in females with higher body mass index. This indicates that high body mass index propose threat for airflow and lung functions in women. Deposition of subcutaneous adipose tissue gravely disturbs mechanics of our respiratory system and decrease in the respiratory compliance. Thus in subjects of high Body Mass Index, the chances of bronchial asthma is more.

KEYWORDS: Peak Expiratory Flow Rate (PEFR), Pulmonary function tests (PFTs), Body Mass Index (BMI), Obesity, Obese, Overweight, Young People

INTRODUCTION

Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (1).

The Peak Expiratory Flow Rate (**PEFR**) is defined as the maximum or peak flow rate that is attained during a forceful expiratory effort after taking a deep inspiration. It is expressed in liters per minute (2). B.M Wright introduced the peak flow meter in 1959 (3). It is measured with Peak Expiratory Flow Meter (Wright Peak Expiratory Flow Meter) which is small and portable device used to monitor a person's ability to breathe out air. The most important use of Peak Expiratory flow (PEF) measurement in clinical medicine is to monitor severity of bronchial asthma, (4). which is more common and harder to treat in the obese population (5).

It Measures the airflow through bronchi and thus degree of obstruction in airways (6). It is fairly a good indicator of bronchial hyper-responsiveness and does not require any body temperature pressure (7). The ability to expire forcefully is what is measured by Peak Flow Meter (6).

There are multiple factors which affect PEF like anthropometric body parameters and also body weight and surface area (7). The anthropometric parameters were recorded from which Body Mass Index were calculated and Peak Expiratory Flow Rate was recorded by using Peak Expiratory Flow Meter (8). In general the PEFR is higher in taller and healthy individuals. Normal males have a higher Peak Expiratory Flow than normal females of the same age and height. The normal range of PEFR in male lies between 450-700 Liters/ min and females have lower range between 300-500 Liters/min (9). The Peak Expiratory Flow Rate reaches a peak at about 18-20 years, maintains this level up to about 40 years in females, and decline with age (10).

Peak Expiratory Flow Rate is determined by lung volume, airway caliber, lung elastic recoil, expiratory

muscle strength (11, 12, 7). It is common clinical observation that if a patient with emphysema is asked to blow out a lighted match with his mouth open he is unable to do it (9).

If spirometry is not available a Peak Flow Meter may be used. Patient should record peak flow readings early in the morning and before bed time. A diurnal variability in peak exipratory flow of more than 20% (the lowest value in morning is considered diagnostic and magnitude of variability provide some indications of disease severity. See fig below (13).

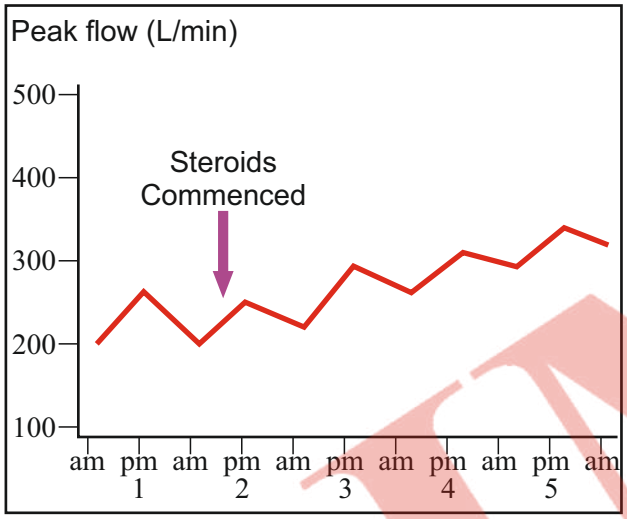

Fig. 1 Serial Recordings pf Peak Expiratory Flow (PEF) in a Patient with Asthma

Note: The sharp overnight fall (morning clip) and subsequent rise during the day. Following the introduction of corticosteroids. There is an improvement in PEF rate and loss of morning clip

The Pulmonary function tests (PFTs) are non invasive tests which help to diagnose patients with obstructive and restrictive lung diseases. Pulmonary Function Parameters are influenced by both relative obesity and body fat (BF) distribution (14).

Pulmonary function tests (**PFT**) using complete spirometry give quantifiable measures of the state of the respiratory system. However, the required instruments are relatively expensive. In contrast Peak Expiratory Flow Rate can be measured using relatively inexpensive Wright's Peak Flow Meter (15).

It is preferred among other pulmonary function test because it is simple and reliable diagnostic and prognostic test (16). This test may also perform in office, emergency department and hospital as well as in home (4). This will help to detect if treatment is effective and if it is preventing the symptoms to get deteriorated (17). It will also enable to see the prognosis of patient with Bronchial asthma . It provide the doctor with information regarding patients breathing variation so that he can adjust the medication accordingly.

The main constraint of peak flow meter is that the results are inconsistent over a long period. Patient has to take effort to do the procedure.The other limitation of this is that it determines the airflow of airways with larger diameter. Medium and smaller diameter airways airflow cannot be determined (18).

Obesity is prevalent in India (19). This trend is common among high-socioeconomic groups, sedentary nlife style among them. High energy food they eat etc (20). A fat distribution in the abdominal area is negatively associated in elderly persons (21). and more common in males. In females adiposity is located in hips and thighs more.

Abdominal obesity is associated with worsening lung function and respiratory symptoms (5). It reduces thoracic wall compliance by restricting diaphragm movement and thoracic cage expansion (22).

The age group of 16 to 25 years is the crucial adolescent age which is highly susceptible for obesity. Very few studies have been conducted for this age group (3).

The World Health Organisation classifies an individual as being “overweight” or “obese” based on their body mass index (BMI) (23). which was calculated from height and weight of the subject by using following formula. BMI= weight (kg) / height (m)2 (24). BMI values are independent and are same for both sexes (25).

According to the World Health Organisation, a person having BMI ≥ 25kg/m2 shall be considered as overweight while obese is defined as having a BMI ≥ 30kg/m2 and for morbid obesity, BMI ≥35 kg/m2 (23). Obesity related morbidities and mortalities are related to its role in many chronic medical problems, including cardiovascular and metabolic diseases, lower back pain, osteoarthiritis and cancer (5).

More than 1.9 billion adults of age group 18 years and above are reported overweight (26). More than 23% of women are either overweight or obese which are higher than the prevalence among men (27). This is because predisposition of fat accumulation is a common occurrence in women as the sex hormones strongly influence adipocyte metabolism (28).

There is a strong association of Obesity with diseases like hypertension, diabetes, hyperlipidemia, vascular dysfunction, respiratory problems. etc (29, 7). Individuals with obesity are more susceptible to many conditions such as Chronic Obstructive pulmonary disease (COPD), obstructive sleep apnea (OSA),

asthma, pulmonary, cardiovascular, obesity hypoventilation syndrome (OHS), pulmonary embolism, aspiration pneumonia, hepatic, renal diseases, metabolic alterations, and neoplasm (30, 7, 5).

PEFR in obese individuals is less as the adipose tissue pose restriction on the movement of chest or abdomen (25). Lung and chest wall compliance is reduced in overweight individuals and it stiffens the thoracic cage leading to dyspnoea during physical activity mainly, even if they don't suffer from any respiratory illness (31).

Obese women, without obvious respiratory illness, have an increased risk of dyspnea during exercise or during slight increase in oxygen cost of breathing. This is because of the extra effort required by the respiratory muscles to tackle the mechanical factors, such as airway and chest wall resistance originated due to increased adiposity (7).

So even with the slight increase in ventilation from resting levels, the oxygen cost of breathing increases which can cause dyspnea. This can lead to early and easy fatigability in the women leading to sedentary life style (7). So it is important to understand the advantage of weight reduction which significantly shows the decline in function (32).

Research have shown that sedentary life style affects inspiratory muscle function and elastic recoil of lungs. These can be improved by doing regular exercise. There still exist paucity of scientific documentation relating to the abstract association of PEFR with Body Mass Index (BMI) and exercise (33).

METHODS

For this review, electronic search of the literature (Google Scholar, PubMed) was performed by using the following key words: 'lung function', 'PEFR' 'airway" 'obese', 'obesity', 'fat', 'fatness', 'adiposity', 'body fat', 'body composition', 'body weight', 'weight gain', 'overweight', 'weight loss','body mass index' and 'BMI', 'youth' or 'young', adult. We also searched the bibliographic references of the articles which were selected related to our study.

On reviewly, 41 articles are selected for this review, the majority of them selected Wright's Peak flow meter for their study.

PROCEDURE

- First of all the subjects were instructed and trained for the procedure of recording of PEFR.
- This training and cooperation of subjects was very essential and it helped for the accuracy of the procedure as the PEFR is a subjective method.
- After that morning hours were preferred for recording of PEFR .
- The subject was advised for maintaining the erect posture and holding the flow meter in horizontal position.
- Care was taken so that pointers on moving a lot was not being obstructed by finger.
- Each subject was instructed to inspire deeply and to keep the mouthpiece of peak flow meter inside the mouth between both the jaws by tight seal around it (but advised not to put her tongue in front of mouthpiece) and to expire forcefully in one blow.
- Each subject was instructed to perform the test three times in similar way, and for analysis of data, the highest PEFR value was kept in record.

DISCUSSION

This study have shown the relation of Body Mass Index with Peak Expiratory Flow Rate and the values of Body Mass Index showed the increasing trend and Peak Expiratory Flow Rate showed the decreasing trend. Sunil Kumar Jena et al (2). studied that with increasing Body Mass Index, the value of Peak Expiratory Flow Rate decreases, hence the correlation between two parameters is shown to be negative. The study of Dharamshi H, Faraz A, et al (34). showed that majority of female subjects, that is about 48.6%, had lesser than 18.5 Kg/m2 Body Mass Index. Because of the negative correlation of Peak Expiratory Flow Rate and Body Mass Index, the Peak Expiratory Flow Rate was also found to be higher male subjects in comparison to female subjects. Vyoma Joshi, Sweety Shah (19). reported that Peak Expiratory Flow Rate and Body Mass Index have a weak correlation.

Babu K.R. (16). shows that in males, the values of Peak Expiratory are more in comparison to females. With increase in height and muscular power, Peak Expiratory Flow Rate is increased hence it is more in males in comparison to female medical students. In female medical students, the Peak Expiratory Flow Rate is low in comparison to male medical students because of less muscle mass replaced by fat deposition and low body frame in females, as compared to males.

Price Jet al (35). shows in their study that there were statistically significant variations in Peak Expiratory Flow Rate and Body Mass Index. According to them 14% of overall population is obese (374$\pm$ 11498L/minute)shows higher peak flow rate value while 3.5% of population has <18.5 Kg/m2 and they show lowest Peak Expiratory Flow Rate values (296$\pm$ 73.12 L/minute). This study also showed that 48% subjects are normal having Body Mass Index 18.5-24.9 Kg/m2 and have normal Peak Expiratory Flow Rate values. For overall population ($r = 0.158$, and $p < 0.01$, figure2)

Peak Expiratory Flow Rate and Body Mass Index show positive relation to each other, while for males (r =0.158, and p<001) and for females (r =0.065 and p<0.01)

Kahlon N et al (36). in their study got the conclusion that in males, the Peak Expiratory Flow Rate has a significant correlation, statistically. There is a negative association between Peak Expiratory Flow Rate and Body Mass Index. While female showed no correlation between two parameters.

According to the study of Sarwari K N, Ali I, Jaleeli K A and Shanmukhappa N.J, (37) there is statistically significant (<0.001,Highly Sensitive) decrease and mean standard deviation is 76.4±7.6 in peak expiratory flow rate (PEFR) in obese female's subjects in compared to non-obese female controls.

The study of Farooq S N, Mustafa S.M, Ahmed A, W Al Harbi (38) showed that there may be limited lung expansion and airflow in obese persons, due to restricted movement of diaphragm which may be due to more adipose tissues deposited in abdominal wall. It is also showed in their study that in comparison to with waist-Hip Ratio, the lung functions show more strong negative correlation with Body Mass Index. In this way, in comparison to overall adipose tissue which is represented by Body Mass Index, the obesity is more important factor. Debray P (15) studied the Peak Expiratory Flow Rate values of Nepalese healthy adults and compared them with the Indian counterparts. He found that there mean show no significant difference.

Malini M (39) observed in his study that in obese persons, the extra adipose tissues in chest wall and abdominal wall are responsible for changes in lung function which is decrease in lung volumes. The chest wall compliance is also reduced due to deposition of fat in and around the ribs, the abdomen and the diaphragm. In obese subjects the Peak Expiratory Flow Rate is decreased and it is because of relation of obesity with increase in total peripheral resistance and airway resistance.

Shenoy J.P (11)., in his study he observed that no significant differences in mean Peak Expiratory Flow Rate on comparison between three groups. A negative correlation of various adipose markers with Peak Expiratory Flow Rate was observed which was more related with central adiposity markers in comparison to Body Mass Index.

Namita, Ranjan P.D,**3** concluded that 76% had normal BMI and not a single participant was obese. About 30% of participants had their Peak Expiratory Flow Rate between 351 and 400 Ipm, while 76.6% had their Peak Expiratory Flow Rate between 301 and 450 Ipm. A significant negative correlation was found between Peak Expiratory Flow Rate and Body Mass Index. As Body Mass Index increases, Peak Expiratory Flow Rate decreases among young people.

Prasoona G.R, Nightigale S.S,(21) concluded that the there was significantly lesser Peak Expiratory Flow Rate values in obese group in comparison to subjects having normal weight. BMI was significantly and negatively correlated with PEFR in Females. Kaur H, Singh J, Makkar M, Singh K, Garg R, (40) concluded that there was a decrease in PEFR with the increase in BMI. But, there was not significant (p>0.05) correlation of Peak Expiratory Flow Rate with Body Mass Index. Patil S.R, Mehta A,(7) concluded that PEFR values were lower in obese women when compared with non-obese women. Dr. Moran N,(41) concluded that there is a negative correlation between BMI and PEFR.

CONCLUSION

Peak Expiatory Flow Rate is affected positively by variation in Body Mass Index. With increased Body Mass Index, Peak Expiratory Flow Rate decreases which signifies that there is bronchoconstriction in persons with increased BMI, due to various mechanisms. Peak Expiratory Flow Rate is reduced in obese females as compared to non obese females because obese individuals have an increased demand for ventilation and breathing work load, accumulation of body fat, respiratory muscles inefficiency, decreased functional residual capacity and expiratory reserve volume and closure of peripheral lung units.

Some studies concluded that PEFR values were lower in obese women when compared with non-obese women. Increased adiposity act as a risk for airflow and pulmonary function in obese women. Deposition of subcutaneous adipose tissue, causes decrease in total respiratory compliance. Thus in subjects of high Body Mass Index the chance of bronchial asthma is more. Subjects were advised about the importance of weight control and regular physical activity which can help them keep free from Bronchial Asthma.. Kahlon N et al(18) concludes that in females, no correlation was found between Peak Expiratory Flow Rate and Body Mass Index or Waist Circumference. Vyoma Joshi, Sweety Shah(14) reported a weak correlation in between Body Mass Index and Peak Expiratory Flow Rate. Price Jet al(30) shows that there was a positive correlation between Peak Expiratory Flow Rate and Body Mass Index for the overall population A large sample size with accurate Peak Flow Meter is required along with ethinic consideration of the study population for better and accurate results. The isolated effects of obesity unassociated with other diseases

must be identified so that obesity related respiratory dysfunction may be evaluated in detail. This aspect is of great value due to rise of obesity and respiratory diseases in society.

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