EUROPEAN JOURNAL OF BIOMEDICAL AND PHARMACEUTICAL SCIENCES
http://www.ejbps.com

ISSN 2349-8870
Volume: 9
Issue: 8
114-118
Year: 2022

COMPARISON OF PEAK EXPIRATORY FLOW RATES OF HEALTHY SUBJECTS WITH DIFFERENT BASAL METABOLIC INDEX

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Article Received on 10/06/2022 **Article Revised on 30/06/2022** **Article Accepted on 20/07/2022**

ABSTRACT
The peak expiratory flow rate is the maximum rate at which the air can be expired after a deep inspiration. It is used to assess respiratory diseases. The peak expiratory flow rate of subjects classified based on their basal metabolic index (BMI) was measured in a semi urban community in Rivers State, Nigeria. This cross-sectional descriptive study was aimed at comparing the peak expiratory flow rate of apparently healthy male and female subjects with different basal metabolic index categorized into normal, overweight and obesed. These subjects were resident in the same community. A total of 168 subjects aged between 18 and 50 years were recruited for the study. Clinical history and clinical examination methods were employed before data collection. Informed consent was obtained. Exclusion criteria in the study included non willingness to participate in the study, any history or previous recent history of any respiratory illnesses or chronic cough, among others. The age and sex of participants were recorded. The subjects' height was taken with the aid of a stadiometer and the weight was measured using a standard weighing scale. The peak expiratory flow rate (PEFR) (L/min) was measured with the Wright's flow meter. The basal metabolic index was calculated using the formula: (weight (kg) / height (m^2). The statistical package for social sciences (SPSS version 21.0) was used for the analysis. The significant differences between and among group means was tested using analysis of variance (ANOVA), and multiple group means were compared using the post hoc test. To determine the link between variables, Pearson correlation analysis was used. The results obtained showed that, In females, there was no significant difference between the mean PEFR of overweight and obesed subjects compared to PEFR of subjects with normal BMI. In males, there was no significant difference between the PEFR of overweight subjects (416.39±21.29) and PEFR of subjects with normal BMI (453.75±20.61), but there was a significant decrease in PEFR of obesed subjects (362.78±18.47) compared to PEFR of subjects with normal BMI. Although average PEFR in normal individuals is higher in males than in females, the reason for the significant decrease in PEFR occurring in obesed males only was not ascertained. In conclusion, obesity in males was found to be associated with significantly reduced PEFR. Therefore, obesity may act as an effective risk factor that increase susceptibility to a decline in respiratory function.

KEYWORDS: *PEFR, obesed, overweight, obesity BMI.*

INTRODUCTION
Following a deep inhalation, Peak Expiratory Flow Rate (PEFR) is the fastest rate at which air may be expelled. It's also the amount of air forcefully released from the lungs in a single fast exhale, and it's a good indicator of both adequate ventilation and airflow restriction. It is a measure of big airway flow that is determined by the patient's or volunteer's voluntary effort and muscular strength. PEFR and FEV1 normally have a good association, however as airflow is reduced in those with pulmonary problems such as asthma, the link weakens (Gibson, 2000). Devrieze 2019, describes PEFR as the maximum flow rate that can be produced during a forceful exhalation or breathing, from full lung inflation. Measured in liters per minute, it has remained a simple and effective method for evaluating ventilatory function (Dikshit *et al.*, 2005), especially in many parts of Africa where medical facilities are still limited, its cost effectiveness makes it a highly valuable lung function test (Elebute & Femi-Pearse, 1971). PEFR has been found to be affected by ethnic and environmental influences in the last 20 years, in addition to age, sex and height (Radeos & Camargo, 2004). The height is a useful parameter in determination of body mass index.

The body mass index (BMI) is a useful measure for determining a person's weight in both health and disease (Price *et al.*, 2013). Adiposity and body composition in adults and children are defined and measured by BMI. It's also known as the Quetelet index, and it's a useful tool for determining body fatness (Frontini *et al.*, 2001). The International Task Force on Obesity has decided that BMI is the best feasible method for defining and screening for overweight or obesity (Himes & Dietz, 1994; Dietz & Robinson, 1998; Zuguo *et al.*, 2002). As a result, BMI is a tool for categorizing persons as overweight, normal weight, or underweight. There is a link between increased body weight and pulmonary impairment, according to studies. Obesity is connected to a number of breathing issues, including obstructive sleep apnea, asthma, obesity hypoventilation syndrome (Tenorio *et al.*, 2012; Murugan & Sharma, 2008). Obesity has a variety of consequences on pulmonary function. To compensate for the normally low tidal volumes, the respiratory rate is usually raised. Total respiratory system compliance is reduced; lung volumes, particularly Expiratory Reserve Volume (ERV), are the respiratory parameters that are most consistently altered. Oxygenation may be hampered, most likely as a result of microatelectasis at the base of the lungs (Saxena *et al.*, 2011; Saraswathi *et al.*, 2014). Furthermore, weight effects on respiratory parameters are usually due to its ability to trigger small airway dysfunction, outflow limitation, change in mechanics of breathing, a reduction in chest wall and lung compliance, among other factors. Most respiratory parameters studied previously showed variations in the measurements obtained in relation to the BMI category.

The FEV1/FVC ratio was found to be significantly different between the BMI groups but higher in underweight group compared to other body mass index groups including the normal weight groups and a positive association with decreasing BMI (Urooj *et al*, 2019). An assessment of expiratory reserve volume (ERV) indicated a negative relationship with underweight, overweight and obesed subjects. This reported decrease in ERV in obesed subjects has been attributed to reduced mobility of diaphragm as a result of increased abdominal volume causing upward pressure of diaphragm resulting in decreased thoracic cavity diameter (Sudhir and Chandrashekara, 2014). There are scanty reports indicating the relationship between peak expiratory flow rate and the body mass index. The purpose of this study is to compare peak expiratory flow rate of subjects belonging to different body mass index.

METHODOLOGY

This is a cross-sectional descriptive study conducted on residents of Igwuruta and Chokocho; sub urban neighbouring towns in Rivers State, Nigeria to examine the relationship between peak expiratory flow rate (PEFR) and body mass index using some anthropometric measurements such as weight and height. Study participants for the research work were selected using simple random sampling, that is, participants were drawn in no particular order. A sample size of 168 subjects [108 males and 60 females] aged between 18 to 55 years was used. Only healthy persons who reside in the study area were included in the study. Clinical history taking and examinations enabled us to identify and exclude those who are asthmatic, persons on bronchodilator medications, persons with chronic cough, tobacco smokers, those having pulmonary tuberculosis and other forms of systemic illnesses and pulmonary diseases. Those who were unable or unwilling to take part in the study were excluded.

The purpose of the study and the procedures was properly explained to the subjects. Age and sex of each subject were recorded. The height (m) and weight (kg) used to calculate BMI were measured using a stadiometer. BMI was calculated using the formula; weight (kg)/ height (m^2). The subjects with different BMI were categorized into Normal (18.5-24.9 kg/m^2), Overweight (25.0-29.9 kg/m^2) and Obesed ≥ 30.0 kg/m^2.

The peak expiratory flow rate (PEFR) (L/min) was measured with the Wright's peak flow meter.

The subjects were seated comfortably. The instructions on how to carry out the test was given and the methods demonstrated. Each subject made three PEFR manoeuvres and the highest reading was recorded as the peak flow rate.

STATISTICAL ANALYSIS

The statistical program for social sciences (SPSS version 21.0) was used for the analysis. The significant differences between and among group means was tested using analysis of variance (ANOVA), and multiple group means were compared using the post hoc test. To determine the link between variables, Pearson correlation analysis was used. Statistical significance was defined as a P value of less than 0.05.

RESULTS

The result for the study is presented in tables 1-4.

Table 1: Mean Peak Expiratory Flow Rate of Females with different BMI.

	BMI	PEFR
BMI. Pearson Correlation Sig. (2 tailed) N	1 60	0 0
PEFR. Pearson Correlation Sig.(2 tailed) N	a 0	a 0

Values are presented as mean±SEM.

Table 2: Correlation between Peak Expiratory Flow Rate and Body Mass Index of Females.

BMI Categories	PEFR (L/min)	Relative Change (%)	Level of Significance
Normal	307.25±25.90	0	_
Overweight	291.80±27.34	-5.03	0.68
Obesed	299.00±26.25	-2.98	0.83

Table 3: Mean Peak Expiratory Flow Rate of Males with different BMI.

BMI Categories	PEFR (L/min)	Relative Change (%)	Level of Significance
Normal	453.75±20.61	0	_
Overweight	416.39±21.29	-8.23	0.19
Obesed	362.78±18.47	-20.05	0.02

Values are presented as mean±SEM.*Differences are considered significant at p<0.05

Table 4: Correlation Between Peak Expiratory Flow Rate and Body Mass Index of Males.

	BMI	PEFR
BMI. Pearson Correlation Sig. (2 tailed) N	1 108	-264 .006 108
PEFR. Pearson Correlation Sig.(2 tailed) N	-264 .006 108	1 108

There is a statistically significant correlation between BMI and PEFR. The correlation is significant at the 0.01 level (2-tailed).

DISCUSSION

The mean PEFR of various BMI categories were measured among residents of sub urban towns in Rivers State, Nigeria. The mean PEFR value for female subjects with normal BMI in this study was 307.25±25.90L/min. The mean PEFR value for overweight and obesed female subjects are 291.80±27.34L/min and 299.00±26.25L/min with a percentage mean difference of -5.03% and -2.98% respectively, relative to control. Although, these differences showed a reduction in mean PEFR in those with abnormal BMI, they were not statistically significant. A correlation of PEFR and BMI of females in this study also showed no association. The mean PEFR for males with normal BMI is 453.75±20.61L/min and mean PEFR in overweight males is 416.39±21.29L/min. Obesed males had a mean PEFR of 362.78±18.47L/min which is significantly (p<0.05) lower by -20.05% compared to PEFR of those with normal BMI. The mean PEFR values for females, shown in table-1 were lower than that for males for both the normal BMI and the overweight and obesed subjects. In other words, The average PEFR values obtained in males were higher than that obtained in females. The findings in this study confirms previously indicated gender differences in PEFR (Price et al., 2013) with the female gender having lower PEFR than their male counterparts. Ijaz et al,. (2020) showed in a study that male participants had sizably higher PEFR values than females (r=0.540, p<0.01). Correlation study showed a significantly negative relationship between PEFR and BMI in males in this study. This is in agreement with the findings of Laxmikant *et al.,* (2014) and Jena et al, (2017) who reportedly found a negative correlation between BMI and PEFR in male subjects with the Pearson correlation coefficient (r) −0.512 (P = 0.000) but contradicts report of Price et al, 2013 who stated that a positive correlation existed between PEFR and BMI in a study involving a sample size comprising 53% males and 47% females. Most studies suggesting a positive correlation between BMI and PEFR only did so in the underweight and normal BMI adults [Dalton *et al.,* (2003); Ijaz et al, (2020)]. Our study took into account mainly the overweight and obesed groups. In all, it becomes apparent to consider a negative correlation existing between PEFR and abnormal BMI categories. Our study and most others reviewed thus far was among normal populations but others was done on a select population of people at risk of developing respiratory dysfunction over a period of time.

In 2014, Das *et al*. found a link between BMI and PEFR in brick industry workers. They hypothesized that the link between a high BMI and a low PEFR indicates that obesity is a significant risk factor for decreased airflow and lung function, and that several mechanisms, including mechanical effects on the diaphragm and fat deposition between muscles and ribs, can lead to an increase in the metabolic demands and workload of breathing, and thus lead to a lower PEFR. However, the PEFR of females in all groups was within normal limits but that of males in the obese category was significantly reduced, while the other groups were still within normal limits. This research backs up comparable and recent studies on PEFR by Edmund *et al.*, (2016) and a few other researchers [Akanbi et al, (2014)] all of which found a persistent decrease in PEFR after extended exposure to cement dust, dust and air pollution. The major factor that affects PEFR is airway diameter primarily influenced by the bronchial tone. The strength of expiratory muscles and elastic recoil of lungs are some other factors affecting PEFR (Sahebjami, 1998). It is imperative therefore, to state that overweight and obesity may have the ability to compromise the airway diameter. Indeed, it has been posited that in obese patients, low tidal breathing does not allow for normal stretching of airway smooth muscle leading to detachment of actin – myosin cross bridges of the airway smooth muscle. The higher the tidal volume, the greater the accompanying bronchial dilation (Gump et al, 2001). This phenomenum known as "deep inhalation effect," restores airways in normal states. This protective effect is less pronounced in obese individuals compared to lean subjects (Boult etal, 2005)

Thus, BMI within normal range would improve PEFR and thus lung function and quality of life.

CONCLUSION

A significantly ($p<0.01$) negative correlation exists between PEFR and BMI mainly in males with abnormal BMI. Mean PEFR values obtained in obesed males are significantly ($p<0.05$) lower compared to males with normal BMI. In addition, male subjects have a higher Mean PEFR value than females. Maintaining a normal BMI would enhance airflow and minimize airway restrictions and it is also essential for optimal physiological function and physical well-being as obesity may act as an effective risk factor that increase susceptibility to a decline in respiratory function. The physiologically healthy BMI levels are essential for the healthy functioning of humans.

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