ORIGINAL ARTICLE

CARDIOPULMONARY FUNCTIONS IN YOUNG MALE AND FEMALE NIGERIANS WITH SIMILAR BODY MASS INDEX

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Background: Weight, height, sex, pregnancy, nutrition, ethnicity, geographical location and technique have been documented to affect cardiopulmonary function. However, inadequate data exist as per comparison of cardiopulmonary parameters between males and females with the similar body mass index. **Methods:** The Peak Expiratory Flow Rate (PEFR) and Pulse Pressure were measured in 120 apparently healthy volunteers in sitting position using mini Wright Peak Flow Meter and mercury sphygmomanometer respectively. Data were presented as Mean±SEM. The means were tested for homogeneity using the student's *t*-test and $p<0.05$ was considered statistically significant. **Results:** PEFR for males was 563.11±15.57 L/min, 466.34±7.32 L/min, and 46.50±1.51 L/min for normal weight, overweight and underweight respectively and these were significantly higher ($p<0.001$) than the corresponding PEFR for females with 391.46±13.37 L/min, 310.22±14.20 L/min, and 348.10±15.62 L/min respectively. The pulse pressure for the male overweight (54.00±3.05) was significantly higher ($p<0.001$) than the pulse pressure for female overweight (42.50±1.70). **Conclusion:** In terms of the body mass index for male and female subjects, there was a discrepancy in the order of the cardiopulmonary function studied. However, the normal weight subjects for both sexes had a balanced homeostasis between respiratory muscular strength and airway resistance for optimal peak expiratory flow rate. The pulse pressure of the overweight males indicates that they have the poorest arterial compliance.

Keywords: Peak Expiratory Flow Rate, Pulse Pressure, Underweight, Overweight, Normal weight, Underweight, Body Mass Index

Pak J Physiol 2016;12(3):27–9

INTRODUCTION

The body mass index is a function of the weight and height of an individual and it serves as a useful guide in classifying individuals as underweight, normal weight, over weight and obese. The overweight and obese people stand at risk of developing many different co-morbidities and health conditions, including respiratory diseases.[1] Excessive weight stiffens the total respiratory system presumably due to its combined effects on lung and chest wall compliance. The breathlessness emanating from this effect is worse during exercise even in the absence of respiratory illness.[2] However, other physiologic parameters such as weight, height[3] and pregnancy have also been shown to influence pulmonary function.[4]

Peak expiratory flow rate (PEFR) can be measured using a peak flow meter. The peak expiratory flow rate signifies the maximum flow that is achieved during forceful expiration after maximal inhalation[5] and it is an indicator of respiratory muscular strength, the extent of airway resistance and elastic recoil pressure of the lungs. These factors have been documented to have geographic, ethnic, racial, socioeconomic, nutritional, genetic and technical variations.[6,7]

Pulse pressure is the difference between systolic blood pressure and diastolic blood pressure. It is a marker of arterial properties and it has been linked to cardiovascular diseases and complications. There is substantial evidence to believe that increasing body mass index is independently associated with decreasing arterial compliance as reflected in the increased pulse pressure in the subjects they studied.[8] However, not much studies have been done comparing cardiopulmonary function in males and females having equal body mass indices. This study was designed to compare the peak expiratory flow rate and pulse pressure in males and females with similar body mass index.

PARTICIPANTS AND METHODS

This cross-sectional comparative study was done among apparently healthy staff and students of St. Philomena Catholic Hospital/School of Midwifery after obtaining permission from the Ethics and Collaboration Committee of the institution. A total of 120 volunteers comprising 60 males and 60 females with age between 20–25 years and height between 1.55–1.65 m participated in the study. Amongst the males, there were 20 participants each in underweight, normal weight, and overweight categories. The 60 female participants also had a similar distribution. A written informed consent was obtained from each participant. Height was measured in meters using a standard Stadiometer, weight was measured in kilogram using the Bathroom Hana Scale. Body Mass Index (BMI) was calculated as

weight in kilograms divided by height in meters squared (BMI=Kg/m^2). Body Mass Index <18.5 Kg/m^2 was taken as underweight, BMI between 18.5 Kg/m^2 and 24.9 Kg/m^2 was considered normal, while BMI between 25.0 Kg/m^2 and 29.9 Kg/m^2 was labeled as overweight.

PEFR was measured with the participants sitting in an upright position using the mini Wright's peak flow meter, which had been calibrated. However, any subject with any of the exclusion criteria[9] for PEFR was disqualified from the study. Prior to peak expiratory flow measurement, participants were instructed on the proper technique for measuring PEFR using Wright's peak flow meter, the participants were asked to empty their bladder and wear loose clothing. For each PEFR measurement, the participants were asked to breathe in as deeply as possible, place the mouth piece in the mouth; lightly bite with the teeth closing the lips on it and with the hand pressing of the nostril to avoid escape of air. The participants were further instructed to blow air into the instrument mouthpiece as hard and fast as possible. The above procedure was done three times consecutively and recorded in liter per minute. The highest of the three test flow rates was used for analysis.

Following a rest period of about 30 minutes, the systolic and diastolic blood pressures of each participant were measured in sitting position on the brachial artery using auscultatory method. Diastolic pressure was determined as the disappearance of the Korotkoff's sound. The pulse pressure was calculated from the difference of the measured systolic and diastolic pressures.

Data were analysed using SPSS-23. Numerical variables were presented as Mean±SEM. The means were tested for difference using Student's *t*-test and $p<0.05$ was taken as statistically significant.

RESULTS

The mean age of the male participants was 22.51±2.48 years and it was 22.33±2.45 years for the females. The mean height for the male participants was 161.7±3.8 Cm while the mean height for the female participants was 159.99±5.1 Cm. The systolic and diastolic blood pressures for the female participants were 121.1±10.9/77.2±11.5, 119.61±11.7/77.11±13.4, and 120.72±11.2/74.12±9.0 mmHg respectively for the underweight, normal weight and overweight categories. The systolic and diastolic blood pressures for the male participants were 120.48±11.1/79.98±12.6, 121.69±12.7/67.69±9.8, and 119.11±12.5/73.11±10.7 mmHg respectively for the underweight, normal weight and overweight categories.

Table-1 shows gender differences of peak expiratory flow rate in each category of BMI. The difference of peak expiratory flow rate between males and females for each category was significant ($p<0.05$).

Table-2 shows gender differences of pulse pressure in each category of BMI. The difference of pulse pressure between males and females was significant only for overweight category ($p<0.05$).

Table-1: Comparison of Peak Expiratory Flow Rates between males and females for the three categories of BMI (L/min, Mean±SE)

Categories of BMI	Peak Expiratory Flow Rate		*p*
	Females	Males	
Underweight	348.10±15.62	457.81±11.51	<0.001*
Overweight	310.22±14.20	466.34±7.32	<0.001*
Normal-weight	391.46±13.37	563.11±15.57	<0.001*

*significant

Table-2: Comparison of pulse pressure between males and females for the three categories of BMI (mmHg, Mean±SE)

Categories of BMI	Pulse pressure		*p*
	Females	Males	
Underweight	49.40±1.61	49.50±1.51	>0.05
Overweight	42.50±1.70	54.00±3.05	<0.001*
Normal-weight	46.60±2.21	46.50±1.51	>0.05

*significant

DISCUSSION

This study revealed that the PEFR for underweight, overweight and normal weight males was significantly higher than that of the female counterparts. This is in consonance with the study by Thurbeckl and Haines[10] that observed that males have a better respiratory function because of their larger lungs per unit stature. The masculine musculature and strength places the males in a better position to overcome airway resistance, elastic and non-elastic tissue resistance of the lungs. Therefore, irrespective of the body mass index the males generate a higher alveolar pressure than their female counterpart to overcome the flow resistance of intra-thoracic/extra-thoracic airways and the resistance due to the peak flow meter. In healthy participants, 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.[11] The PEFR for females decreased in the order: normal weight>underweight>overweight implying that overweight female has the highest respiratory resistance with the least muscular strength. This pattern is consistent with the study by Laxmikant *et al*[12] although their study was on males alone. PEFR is documented to be dependent upon airway resistance, maximal ventilatory muscular effort and the possible compressive effect of the maneuver on the thoracic airways.[13–15] The order of PEFR for males is at variance with that of their female counterpart with a decreasing order of normal weight>overweight>underweight; this order is however at variance with the study by Laxmikant *et al*[12]. Thus, the underweight male subjects had the least respiratory muscular strength to overcome the airway respiratory resistance, whereas the respiratory muscular strength of

the overweight more than compensated for the airway resistance associated with the body mass index. Airway resistance has been shown to increase approximately by 33%, 49%, and 62% for people with BMI values of 30, 35, and 40 Kg/m^2, respectively.[16,17] The normal weight participants for both sexes had a balanced homeostasis between respiratory muscular strength and airway resistance for optimal peak expiratory flow rate. From this study, the pulse pressure for males decreased in the order: overweight>underweight>normal weight. On the other hand, the order of pulse pressure for the female subjects decreased in this order: underweight>normal weight>overweight. Thus, there was a discrepancy between the order of pulse pressure in relation to body mass index between the male and female participants. The pulse pressure of the overweight males indicates that they have poorest arterial compliance.

CONCLUSION

In terms of the BMI for male and female participants, there was a discrepancy in the order of cardiopulmonary function studied. However, the normal weight subjects for both sexes had a balanced homeostasis between respiratory muscular strength and airway resistance for optimal peak expiratory flow rate. The pulse pressure of the overweight males indicates that they have the poorest arterial compliance.

ACKNOWLEDGEMENT

We use this medium to acknowledge the staff and students of the St. Philomena Catholic Hospital/School of Midwifery for their support during this research.

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