Anthropometric Measurements And Peak Expiratory Flow Rate Variability: A Cross-Sectional Study Among Adults In A Nigerian University Population

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Abstract

Peak expiratory flow rate (PEFR) is a quantifiable lung function test used to evaluate lung function, diagnose lung disease, and monitor prognoses. This study assessed the variations of PEFR with anthropometric measurements in a population of adults in a Nigerian university. The protocol for this cross-sectional study was approved by the Health Research Ethics Committee of the University of Nigeria Teaching Hospital. Data were analyzed using the IBM SPSS Version 29.0. Descriptive statistics were used to summarize data. A correlation test was used to test the relationship between the continuous variables. Independent t-test was used for the mean difference analysis. Statistical significance was set as $p < 0.05$.

There were 391 participants. The majority of the participants were between 21 to 30 years old (n = 274, 70.1%), female (n = 247, 63.2%), and had no previous asthma diagnosis (n = 378, 96.7%). The mean age (in years) was 25.51 ± 6.54. The mean PEFR was 428.79 ± 87.85 (L/min) [Normal: 400 – 700 L/min]. There was positive correlation between age and PEFR (r = 0.106, p = 0.036); height and PEFR (r = 0.422, p < 0.001); weight and PEFR (r = 0.307, p < 0.001); waist circumference (WC) and PEFR (r = 0.156, p = 0.002); waist-hip ratio (WHR) and PEFR (r = 0.136, p = 0.007). Males had higher mean PEFR (495.10 Vs. 390.12, t = 13.938, p < 0.001) than females.

Our conclusion was that peak expiratory flow rate is influenced by anthropometric measurements such as age, height, weight, waist circumference, and waist-hip ratio. Healthy lifestyle measures related to diet and aerobic exercise should be encouraged among adults to keep their weights, waist circumference, and waist-hip ratio within normal ranges.

Keywords: Anthropometry; Asthma; Chronic Obstructive Pulmonary Disease; Peak expiratory flow rate; Peak flow meter

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Introduction

Pulmonary function tests (PFTs) are vital tools for assessing lung function and play a crucial role in diagnosing and monitoring respiratory disorders.[1] Peak expiratory flow rate (PEFR) holds particular importance as a widely used pulmonary function test.[2] PEFR quantifies the maximum airflow that can be forcefully exhaled during a forced expiration from a maximal inhalation.[3,4] It is a vital indicator for diagnosing and monitoring respiratory conditions, assessing the severity of airflow limitation, evaluating treatment effectiveness, and predicting exacerbations.[4,5]

Anthropometric measurements such as height, weight, body mass index (BMI), and other physical characteristics have been shown to influence PEFR values.[6-8] Studies have shown variations in PEFR values with age, sex, race, ethnicity, posture, geographical, and nutritional factors.[6] These factors affect the expiratory muscle strength, lung volumes, and airway dimensions, which in turn affect lung function.[6,9] By incorporating anthropometric measurements into reference standards, healthcare professionals can establish more personalized and precise benchmarks for assessing asthma control and other respiratory conditions.

Despite the observed influence of anthropometric measures on PEFR values, there is a paucity of data on PEFR variations among healthy adults in Nigeria.[10-12] This study aims to fill this gap by investigating the variations of PEFR with anthropometric measurements in a population of adults

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in a Nigerian university. By examining these variations, we can provide valuable insights into the impact of physical characteristics on PEFR values and contribute to the development of more accurate reference standards for clinical practice within the Nigerian context.

Materials and Methods

Study design/setting

This cross-sectional study was conducted in a first-generation Nigerian university.

Eligibility criteria

Adults (16 years old and above) in the university who provided consent and were willing to participate in the study were eligible. This included students, members of staff, and those who were neither students nor members of staff but were in the university when the study was conducted in November 2022.

Sample size and selection

The sample size was calculated with an estimated total population of adults at the university. The required sample size was calculated using the Raosoft® sample size calculator, with a 5% margin of error, at a 95% confidence interval, assuming a 50% response rate.[13] With an estimated total population of 43,108 adults, the minimum recommended sample size was 381. Convenience sampling was employed. Stands were set up in a busy area on campus and those who approached and met the eligibility criteria were included.

Data collection

The study instrument comprised two domains. The first domain requested demographic information and consisted of eight items. The second domain was for anthropometric and PEFR measurements. The anthropometric measurements of the participants were determined using standard equipment. Height was measured to the nearest 0.5 cm using a power tape (manufactured by CEMEZ®) placed on an erect pole. Weight was measured with a calibrated standard electronic weighing scale (Manufactured by Hana®) to the nearest 0.1 Kg. BMI was calculated as weight (Kg) divided by the square of height (m^2). Waist circumference (WC) was measured at the level of the umbilicus with a flexible measuring tape (manufactured by GDMINLO®). Hip circumference (HC) was measured at the widest girth of the hip using the measuring tape (manufactured by GDMINLO®). Waist-hip ratio (WHR) was obtained by dividing the waist circumference by the hip circumference. Chest circumference (CC) was measured at the level of the nipple, at the end of expiration, to the nearest 0.1cm using the measuring tape (manufactured by GDMINLO®). PEFR was measured with the peak flow meter (manufactured by OMRON®). The personal best was documented as the highest of three blows.

Data analysis

Data were analysed using the IBM SPSS Version 29.0 (IBM Corp, Version 29.0, Armonk, NY, USA). Descriptive statistics (e.g., frequency, percentages, mean, standard deviation) were used to summarize data. A correlation test was used to test the relationship between the continuous variables. Independent t-test was used for the mean difference analysis. Statistical significance was set as $p < 0.05$.

Ethical approval

Health Research and Ethics Committee (HREC) of the University of Nigeria Teaching Hospital (UNTH), Ituku-Ozalla, Enugu State approved the study protocol before the commencement of the study (NHREC/05/01/2008B-FWA00002323 8-1RB00002323). Informed consent was obtained from the participants before participation. Participant names were not collected.

Results

There were 391 participants. The majority of the participants were between 21 to 30 years old (n = 274, 70.1%), female (n = 247, 63.2%), and had no previous asthma diagnosis (n = 378, 96.7%). The mean age (in years) was 25.51 ± 6.54, Table 1.

The mean body mass index (BMI) for the participants was 25.52 ± 4.02 (Kg/m^2). The mean waist-hip ratio (WHR) was 0.82 ± 0.09 (cm). The mean chest circumference (CC) was 92.60 ± 11.62 (cm). The mean peak expiratory flow rate (PEFR) was 428.79 ± 87.85 (L/min). Less than half of the participants had a BMI within the normal range (18.50 Kg/m^2 – 24.99 Kg/m^2) (n = 187, 47.8%), Table 2.

There was positive correlation between age and the other variables: height ($r = 0.142$, $P = 0.005$), weight ($r = 0.222$, $p < 0.001$), BMI ($r = 0.147$, $p = 0.004$), WC ($r = 0.258$, $p < 0.001$), HC ($r = 0.122$, $p = 0.016$), WHR ($r = 0.155$, $p = 0.002$), CC ($r = 0.131$, $p = 0.009$) and PEFR ($r = 0.106$, $p = 0.036$). There was a positive correlation between height and PEFR ($r = 0.422$, $P < 0.001$); weight and PEFR ($r = 0.307$, $p < 0.001$); WC and PEFR ($r = 0.156$, $p = 0.002$); WHR and PEFR ($r = 0.136$, $p = 0.007$), Table 3.

Males had higher mean PEFR (495.10 Vs. 390.12, $t = 13.938$, $p < 0.001$) than females. Those who were previously diagnosed with asthma had higher mean WHR than those who were not (0.86 Vs. 0.82, $t = 1.427$, $p = 0.036$). Those who smoked cigarettes had higher mean WHR (0.85 Vs. 0.82, $t = 2.299$, $p = 0022$), mean chest circumference (96.39 Vs. 91.89, $t = 2.822$, $p = 0.005$) and mean PEFR (475.73 Vs. 419.94, $t = 4.709$, $p < 0.001$) than non-smokers, Table 4.

Table 1: Sociodemographic information, N = 391

Variables	n (%)
Age (in years)	
≤20	62 (15.9)
21 – 25	190 (48.6)
26 – 30	84 (21.5)
31 – 35	21 (5.4)
36 – 40	18 (4.6)
41 – 45	9 (2.3)
46 – 50	5 (1.3)
51 – 55	1 (0.3)
56 – 60	1 (0.3)
Gender	
Male	144 (36.8)
Female	247 (63.2)
Previously diagnosed with asthma	
Yes	13 (3.3)
No	378 (96.7)
Family history of asthma	
Yes	8 (2.0)

Table 2: Anthropometric (height, weight, body mass index, waist circumference, hip circumference, waist hip ratio, chest circumference) and peak expiratory flow rate values N = 391

Variables	Mean ± SD
Anthropometric and PEFR values	
Height (m)	1.70 ± 0.09
Weight (Kg)	74.07 ± 12.43
BMI (Kg/m^2)	25.52 ± 4.02
WC (cm)	81.78 ± 10.10
HC (cm)	99. 77 ± 12.10
WHR	0.82 ± 0.09
CC (cm)	92.60 ± 11.62
PEFR (L/min)	428.79 ± 87.85
Classification of BMI and WHR	
BMI (Kg/m^2)	
Underweight (≤18.49)	9 (2.3)
Normal (18.50 – 24.99)	187 (47.8)
Overweight (25.00 – 29.99)	147 (37.6)
Obese (≥30.00)	48 (12.3)
WHR (Females), N = 247	
Normal (≤0.85)	198 (80.2)
High (> 0.85)	49 (19.8)
WHR (Males), N = 144	

Table 3: Relationship between anthropometric (height, weight, body mass index, waist circumference, hip circumference, waist -hip ratio, chest circumference) and peak expiratory flow rate variables, N = 391

Variables		Age (in years)	Height (m)	Weight (Kg)	BMI (Kg/m^2)	WC (in cm)	HC (in cm)	WHR	CC (in cm)	PEFR (L/min)
Age (in years)	**r**	-	0.142	0.222	0.147	0.258	0.122	0.155	0.131	0.106
	p	-	0.005*	<0.001*	0.004*	<0.001*	0.016*	0.002*	0.009*	0.036*
Height (m)	**r**	0.142	-	0.443	-0.173	0.201	0.107	0.095	0.192	0.422
	p	0.005*	-	<0.001*	0.001*	<0.001*	0.035*	0.062	<0.001*	<0.001*
Weight (Kg)	**r**	0.222	0.443	-	0.802	0.744	0.645	0.114	0.559	0.307
	p	<0.001*	<0.001*	-	<0.001*	<0.001*	<0.001*	0.024*	<0.001*	<0.001*
BMI (Kg/m^2)	**r**	0.147	-0.173	0.802	-	0.672	0.633	0.056	0.486	0.055
	p	0.004*	0.001*	<0.001*	-	<0.001*	<0.001*	0.270	<0.001*	0.279
WC (in cm)	**r**	0.258	0.201	0.744	0.672	-	0.622	0.440	0.544	0.156
	p	<0.001*	<0.001*	<0.001*	<0.001*	-	<0.001*	<0.001*	<0.001*	0.002*
HC (in cm)	**r**	0.122	0.107	0.645	0.633	0.622	-	-0.382	0.628	0.018
	p	0.016*	0.035*	<0.001*	<0.001*	<0.001*	-	<0.001*	<0.001*	0.721
WHR	**r**	0.155	0.095	0.114	0.056	0.440	-0.382	-	0.006	0.136
	p	0.002*	0.062	0.024*	0.270	<0.001*	<0.001*	-	0.901	0.007*
CC (in cm)	**r**	0.131	0.192	0.559	0.486	0.544	0.628	0.006	-	0.046
	p	0.009*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	0.901	-	0.364
PEFR (L/min)	**r**	0.106	0.422	0.307	0.055	0.156	0.018	0.136	0.046	-
	p	0.036*	<0.001*	<0.001*	0.279	0.002*	0.721	0.007*	0.364	-

Discussion

The majority of the participants were females. This is consistent with a similar study in Nigeria which reported more female than male respondents.[10] Possibly, females were more interested in participating in the study due to the anthropometric measurements,

Table 4: Mean difference analysis for some anthropometric measurements (hip circumference, waist hip-ratio, chest circumference) and peak expiratory flow rate, N = 391 (df = 389)

Variables		Mean ± SD											
		HC (in cm)	t	P	WHR	t	P	CC (in cm)	t	P	PEFR (L/min)	t	P
Gender	Male (n = 144)	97.20 ± 13.03	-3.251	0.001*	0.86 ± 0.09	6.070	<0.001*	92.92 ± 12.98	0.415	0.678	495.10 ± 83.81	13.938	<0.001*
	Female (n = 247)	101.27 ±11.28			0.80 ± 0.08			92.42 ± 10.77			390.12 ± 63.86		
PDA	Yes (n = 13)	103.71 ± 12.11	1.195	4.076	0.86 ± 0.06	1.427	0.036*	99.43 ± 14.06	2.165	7.063	429.23 ± 129.71	0.019	0.985
	No (n = 378)	99.63 ± 12.09			0.82 ± 0.09			92.37 ± 11.47			428.77 ± 86.31		
I smoke	Yes (n = 62)	99.14 ± 9.98	-0.445	0.657	0.85 ± 0.08	2.299	0.022*	96.39 ± 10.38	2.822	0.005*	475.73 ± 82.31	4.709	<0.001*
	No (n = 329)	99.89 ± 12.47			0 82 ± 0.09			91.89 ± 11.71			419.94 ± 86.15		

*P < 0.05 is considered statistically significant; PDA = Previously diagnosed of asthma; BMI = Body Mass Index; HC = Hip Circumference; WHR = Waist-Hip Ratio; CC = Chest Circumference; PEFR = Peak Expiratory Flow Rate; df = Degree of freedom; SD = Standard Deviation

as the literature suggests that women are more frequently dissatisfied with their weight, perceiving themselves as heavier than they are.[14] In contrast, a similar study among medical students in India reported more male than female respondents.[7]

Less than a tenth of the participants had a family history of asthma or had been previously diagnosed with the disease. Peak flow meter can serve as a useful tool to monitor airway patency; particularly in those who have a family history of bronchial asthma.[15] Almost half of the participants had a respiratory illness the week before the commencement of the study. Although the acute effects of respiratory illness on peak expiratory flow have been investigated less often, they have been consistently associated with reduced expiratory flow in those with and without asthma.[16,17]

The mean PEFR for the participants was within the range of normal adult peak flow scores as referenced by the British Heart and Lung Foundation (between 400 and 700 litres per minute).[18] This is consistent with a similar study in India which recorded normal mean values of PEFR in male and female respondents.[7]

The mean BMI for the participants was above the normal range and more than four-fifths of the participants had normal waist-hip ratio. A similar study in Nigeria reported a normal mean BMI value of 22.6 kg/m^2, but their respondents had a normal waist-to-hip ratio of 0.81.[10] While one could easily attribute this high mean BMI of our participants to unhealthy dietary lifestyle practices usually imbibed by students for socio-economic reasons, it is important to note that BMI is no longer used alone for weight measurement especially in women of African origin as they have and maintain less weight loss than their white counterparts.[19] Instead, in adults with a BMI below 35 kg/m^2, a combined measure of their waist-to-height ratio and a practical estimate of central adiposity are used to predict health risks.[20]

There was a positive correlation between age and PEFR. This finding is consistent with various studies.[10,12] Advancing age has been associated with decreased expiratory strength, elastic recoil of the lungs, and airway size, thereby causing a decline in lung function and a low PEFR value.[6,21]

This study showed a positive correlation of PEFR values with height and weight. This is consistent with the findings of a similar study.[12] As lung size increases proportionally with body size, tall individuals have greater lung capacity than shorter individuals. Contrarily, obesity has been shown to cause airway limitations, accounting for a decreased PEFR value with increasing weight.[6]

There was a positive correlation between WC and PEFR. This was similar to the findings of a study conducted among apparently healthy adults in a Nigerian university.[10] In contrast, no relation was found between PEFR and WC in a similar study conducted among medical students in Pakistan.[22] In addition, a study carried out on anthropometric determinants of lung function in apparently healthy individuals working at two government agencies and one private office environment in Abeokuta, Ogun State, Nigeria, showed no significant correlation between the WC of participants and the pulmonary function parameters.[12]

There was a positive correlation between WHR and PEFR. However, some studies reveal a contrasting report, with a negative correlation between WHR and PEFR.[10,23] In our study, male participants had higher mean PEFR than females. This is consistent with findings from similar studies.[7,10-12, 24] This could be attributed to the greater lung size and capacity in males, compared to females.[6,25] Those who were previously diagnosed with asthma had higher mean WHR than those who were not. This is supported by the findings from a study among individuals residing in the United States.[26] Reduced respiratory function is associated with higher WHR.[27] Those who smoked cigarettes had higher mean WHR, mean CC, and mean PEFR than non-smokers. Cigarette smokers have been reported to have higher WHR and CC.[28-30] However, most studies provide evidence for a decrease in PEFR among cigarette smokers.[31-33]

This study had some limitations. The location of the stand for the study could have influenced the demographics of the study participants. Although it was in a busy area of the university, it was mainly students who walked past. Some university staff and business owners declined participation, with their tight schedules being a major reason. Furthermore, the use of one location could have reduced the variations in the demographics of the participants. Some participants declined when it got to the PEFR measurements, as they were uncomfortable with blowing into the peak flow meter. The study was cross-sectional by design and conducted in a single university. Hence, the findings might not apply to other study settings.

The findings reveal that peak expiratory flow rate is influenced by anthropometric measurements such as age, height, weight, waist circumference, and waist-hip ratio. Healthy lifestyle measures related to diet and aerobic exercise should be encouraged among adults to keep their weights, waist circumference, and waist-hip ratio within normal ranges.

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