RESEARCH ARTICLE

Impacts of adiposity parameters on peak expiratory flow rate in healthy young adults of Bahria University Medical and Dental College Karachi: Cross-sectional study

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Abstract

Objectives: To explore the association of various adiposity parameters in young adults.

Method: The cross-sectional study was conducted at Bahria University Medical and Dental College, Karachi, from January to February 2021, and comprised healthy medical students aged 19-21 years. Height, weight, body mass index, waist circumference, waist-hip ratio and percentage body fat were recorded. Peak expiratory flow rate was determined using Wright's meter, and its association with adiposity markers was determined using regression analysis. Data was analysed using SPSS 22.

Results: Of the 162 subjects, 96(59.3%) were females and 66(40.7%) were males. The overall mean age was 20.18±1.01 years. Peak expiratory flow rate was significant positively associated with height, body mass index, waist circumference, and percentage body fat ($p<0.05$). It had weak negative association with waist-hip ratio($p>0.05$).

Conclusion: Peak expiratory flow rate increased with height, body mass index, waist circumference, and percentage body fat in healthy subjects.

Keywords: Peak expiratory flow rate, Waist-hip ratio, Body mass index, Visceral fat percentages, Young healthy adults. (JPMA 72: 1513; 2022)

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Introduction

Airway obstruction and obesity are challenging health issues in the modern world. Air pollution is increasing at an alarming rate due to industrialisation, intense energy consumption, and increased emissions from transportation in the process of industrialisation and urbanisation globally. Air pollution has detrimental effects on the respiratory system.[1] Trend of increasing obesity due to sedentary lifestyle is another contributing factor in the impairment of lung function and airway obstruction.[2] Both the serious comorbidities can adversely affect overall health, quality of life (QOL), and life span of individuals.[1,2]

Due to the increasing prevalence of pollution and smoking in the developing countries, the burden of chronic obstructive pulmonary disease (COPD) is expected to rise at an alarming rate, and the death rate by 2030 is expected to be increased by 4.5 million due to COPD and related conditions due to increasing air pollution and environmental tobacco smoke in the developing countries.[3] Early stages of COPD can be asymptomatic and cannot be picked by force expiratory volume in the first second (FEV1), so it is frequently misdiagnosed until it is clinically apparent.[4] According to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines, spirometer parameters FEV1 and force vital capacity (FVC) are the gold-standard tests for determining airway obstruction in only symptomatic patients, but are not recommended for asymptomatic individuals.[3] Moreover , FEV1 is an unreliable marker to assess the severity of breathlessness, exercise limitation, and health status impairment.[3] Peak expiratory flow rate (PEFR) is a convenient method of assessing lung functions and is widely used as a screening tool in researches instead of spirometry.[5] It can be easily measured even by untrained individuals with an inexpensive portable Mini-Wright peak flow meter.[6] PEFR, due to its compactness, cost-effectiveness, feasibility and simplicity of manoeuvre, has made it preferable over FEV1.[7] The selection of PEFR was dominant because it is generally recognised as a trustworthy parameter and a simple index of pulmonary functions which measures the caliber of the airways and severity of airway obstruction. Furthermore, PEFR can easily detect even symptomless early stages of airway obstruction with 77-83% sensitivity and 81-88% specificity, indicating the diagnostic accuracy.[7]

GOLD guidelines encourage future researchers globally to develop innovative approaches for early screening of asymptomatic and undiagnosed COPD patients for planning its management and prevention to reduce its

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burden on societies.[3] Now researchers are focusing on PEFR, which is one of the highly accurate and sensitive indexes, for assessing compromised lung functions, especially in high-risk groups, like those with obesity.[6,7] Strong evidence shows that lung functions are severely compromised by obesity.[8] Gaining excessive weight may have a deteriorating effect on lung functions, including, small airway dysfunction, alterations in pulmonary mechanics, decreased respiratory muscle strength and endurance, causing limitations in expiratory flow rate and exercise capacity.[8] The truncal fat may compress the chest cavity and restrict the diaphragmatic movement, resulting in reduced vertical diameter of the thoracic cavity and lung expansion.[8,9] These changes may reduce the compliance of the lungs and the thoracic cavity and increase the load on the respiratory muscles. This may end up with a reduction in lung volumes and flow rates.[8] Young medical students are at a higher risk of obesity due to lifestyle factors, like prolonged sitting in front of computers daily due to online sessions, overeating during times of stress and lack of physical activity.[10] Unhealthy eating habits, including energy-dense fast food consumption, during their group studies play a significant role in adding up to obesity.[10] Association of lung functions with adiposity parameters, including percentage body fat (PBF), body mass index (BMI) and waist-hip ratio (WHR), has recently attracted the interest of researchers.[2,9] However, most studies include either children or people aged >50 years.[2,6] Young adults aged 16-25 years is a high-risk group for obesity and comprised lung functions, but has not been focussed upon by researchers in this context. Moreover, data concerning the association of PEFR with adiposity markers for this vulnerable age group is limited.[11] The current study was planned to fill the gap by assessing the lung function of young adults using PEFR, and to find the impact of adiposity parameters on PEFR.

Subjects and Methods

The cross-sectional study was conducted from January to February 2021 at Bahria University Medical and Dental College (BUMDC), Karachi. After taking approval from the institutional ethics review committee, the sample size was calculated using the World Health Organisation (WHO) calculator with level of significance 5%, power of study 80% and prevalence of obesity 11.9%.[12,13]

Those included were healthy non-smoker first and second year medical students having no medical illness, like cardiorespiratory issues, neurological diseases, hormonal disorders and allergic conditions. Subjects were recruited by convenience sampling technique Subjects with a habit of smoking, alcohol consumption and history of any disease or allergy were excluded.

After taking written informed consent from all the subjects, relevant information about age, ethnicity, etc. were noted on a structured proforma.

BMI was calculated as body weight (BW) in kgs divided by the square of height in meters (m^2). The subjects were weighed on a weighing scale (ZT-120) in kgs in their normal clothing without shoes. Standing body height (BH) was measured without shoes to the nearest 0.5cm with the help of a height scale (ZT-120) with the shoulders in a relaxed position and arms hanging freely. WHR was calculated from the recorded waist and hip circumferences. Waist circumference (WC) was measured in cms at a midway point between the lower rib and iliac crest with the help of stretchable measuring tape while the subject was standing upright. Hip circumference (HC) was recorded from the widest girth of the hip. WC and HC measurements were recorded to the nearest 0.1cm. Body fat content was calculated using the sum of 3 triceps skinfold measurements using a Vernier caliper. BMI was categorized as per the standard World Health Organization (WHO) classification of obesity for Asians. Underweight (BMI<18.5 kg/m2), normal weight (BMI 18.5-22.9 kg/m^2), overweight (23-24.9 kg/m^2) and obese (BMI>25kg/m^2)[14] WHR cut off points for Asian males and females are 0.9 and 0.80 respectively.[15]

Wright's peak flow meter was used for the determination of PEFR. Each subject was instructed to take maximum inspiration and to blow into the mouthpiece of the meter as rapidly, forcefully and completely as possible. They were trained well to blow into the instrument maintaining a tight sealing of the meter between the lips and the mouthpiece. Three consecutive readings were recorded at about 2min intervals, and the maximum of the three values was used.

Data was analysed using SPSS 22. Continuous variables were expressed as mean ± standard deviation (SD). The normality of data was checked using the Shapiro Wilk test, and was found to be normaly distributed. One-way analysis of variance (ANOVA) was used to determine the difference between the mean values among the various categories of adiposity parameters. Simple linear regression analysis was used to analyse the association of PEFR with BH, BW, BMI, WC, BFP and WHR. Results of regression analysis were presented as a standardized beta coefficient (β) and standard error (SE) to measure the strength of association. $P \leq 0.05$ was considered statistically significant.

Results

Of the 162 subjects, 96(59.3%) were females and

Table-1: Variation in PEFR with respect to height, weight and waist circumference (n=162).

	Frequency N= 162	PEFR L/min (Mean ± SD)	P value
Height (cm)			
144-153	06	271.00±48.75	
154-163	49	349.70± 98.80	
164-173	68	383.13±94.97	0.02*
174-183	39	391.92±84.58	
Weight (Kg)			
42-51	33	374.55± 113.36	
52-61	62	357.60±83.46	
62-71	46	368.30± 86.13	0.28
72-81	16	413.44± 117.76	
82-95	5	404.00± 95.28	
Waist circumference (cm)			
60-69	19	334.74± 37.76	
70-79	69	349.10±72.30	
80-89	57	385.61± 108.68	<0.001*
90-99	14	459.29± 133.15	
100-106	3	416.67± 28.86	

PEFR: Peak expiratory flow rate, SD: Standard deviation. L/min: Liter per minute.
P≤0.05 was considered statistically significant.

Table-2: Impact of adiposity parameters on PEFR (n=162).

	Frequency N= 162	PEFR L/min (Mean ± SD)	P value
Waist Hip Ratio (WHR)			
0.39-0.59	12	426.08±142.37	
0.60-0.80	61	354.67±74.51	0.11
0.81-1.01	88	375.25±98.90	
1.02-1.22	1	350.00±18.00	
Percentage Body Fat (PBF)			
11-22	43	371.37±63.50	
23-34	71	341.55±104.22	
35-46	2	400.00±70.71	<0.001*
47-58	4	353.75±66.00	
59-70	42	420.81±91.59	
Body Mass Index (BMI) (Kg/m^2)			
Underweight <18.5	07	284±41.97	
Normal weight 18.5 -22.9	105	364.45±87.24	0.01*
Overweight 23-24.9	24	387.37±102.900	
Obese ≥ 25	26	405.88±88.4	

PEFR: Peak expiratory flow rate, SD: Standard deviation, L/min: Liter per minute.
BMI cut off points are according to WHO classification of obesity for Asians.
P≤0.05 was considered statistically significant.

66(40.7%) were males. The overall mean age was 20.18±1.01 years. The overall mean PEFR of sample was 371.04±95.24L/min, mean BH was 165 ±3.1, mean weight 60.54±10.21, mean BMI was 22.17±3.17, mean WC was 78.7±8.44 and mean WHR was 0.79±0.13.

Taller subjects had higher PEFR values (p =0.02) WC also had a significant association (p=0.001) (Table-1).

Table-3: Regression analysis between adiposity parameters and PEFR (n=162).

Variables	β	SE	P= Value
Height	2.19	0.97	0.02*
weight	0.07	0.90	0.93
Body mass Index (BMI)	5.70	2.34	0.01*
Waist circumference (WC)	3.11	0.85	<0.001*
Waist -Hip ratio (WHR)	-35.39	24.9	0.52
Percentage Body Fat (PBF)	1.33	0.39	0.00*

PEFR: Peak expiratory flow rate, SE: Standard error, β: Beta coefficient, L/min: Liter per minute.
P≤0.05 was considered statistically significant.

Significant differences in mean PEFR were observed in different categories of BMI (p =0.01) and PBF (p=0.001), but no statistical difference was observed concerning WHR (p=0.11) (Table-2).

PEFR was significantly associated with BH, BMI, WC and PBF (p<0.05), while it had a non-significant association with BW and WHR (p>0.05) (Table-3).

Discussion

The main dynamics that influence PEFR is the force of contraction of the expiratory muscles, recoil pressure of the lungs, movement of the diaphragm and airways competency. Different physical parameters, like height and weight, previously reported a significant correlation with PEFR.[16] Obesity is escalating at an alarming rate globally across age groups, leading to reduced capacity of the pulmonary system due to excess accumulation of fat on the abdominal and thoracic region that may limit movements of the diaphragm and lung expansion.[16] The current study was aimed at determine the association of PEFR with adiposity parameters, including BW, BMI, PBF and WHR, among young adults. BW and BMI are best indicators of overall adiposity, whereas PBF, WC and WHR are the measures of central obesity and indicate adverse outcomes of cardiorespiratory morbidity.[17]

In the current study, a statistically significant positive association was seen between PEFR and BH, which is in line with studies conducted in Pakistan and Malaysia.[8,18] The most probable reason for higher PEFR in taller subjects might be because of the greater chest diameter, more development of the airways and expiratory muscles.[6] The present study did not find any significant variation in PEFR value with BW change. In contrast, a study done in Faisalabad, Pakistan, reported a decrease in PEFR values with BW increase.[19] Another study reported that PEFR upsurges to a certain level with increasing BH and BW, and then declines as BH and BW increase further.[15]

Previously, obesity has been linked with impaired pulmonary function.[20] In the current study, significant positive association of PEFR was observed with BMI. Contradictory to the findings, a study in India reported higher PEFR values in non-obese subjects.[21] A study in Pakistan did not find any association of PEFR with BMI.[19]

Increased PBF is detrimental to lung function and is related to several pulmonary diseases, but conflicting results have been reported concerning its relation with PEFR.[21] PBF is theoretically related to decreased pulmonary function through the mechanism of inhibition of diaphragmatic movement into the abdominal cavity due to accumulation of fat,[22,23] but the current outcomes are opposite to this theory and revealed a significant positive association of PEFR with PBF. A study in Indonesia reported similar findings, but its findings were inconsistent concerning obese and overweight subjects and reported a negative association of PBF with PEFR in those subjects.[23] The current findings are incompatible with a recent study in Taiwan that demonstrated a negative impact of higher PBFon lung function in both genders.[22]

The present study showed a negative association of WHR with PEFR, However, this association was not significant which might be because of the small sample size. This observation is in agreement with the earlier findings of a study done in India.[24] The current results are also in line with another Indian study which reported negative association of PEFR values with WHR in the male gender only, but the finding was not consistent for the female gender.[17] Interestingly, when the aforementioned study analysed the combined data for both genders simultaneously, it found positive relation of PEFR with WHR.[17]

The current findings revealed significant positive association of PEFR with WC, which was reported earlier by an Indian study.[17] Moreover the earlier study also documented a negative association of WC with PEFR only in males, but not in females, on analysing the data separately for the two genders.[17] That is because of the fact that in females fat deposits more around the hip region, whereas in males the adiposity is usually developed in the abdominal region. Over-deposition of fat in the abdomen and thorax may limit the diaphragmatic activity and reduce the pulmonary compliance in males, so the negative effect of WC on pulmonary function in males is comparatively greater than females.[17] A study in Iran also reported negative association of detrimental adiposity parameters, WC and WHR with lung function parameters, including PEFR.[25] Contradictory to the current findings, earlier studies did not find a significant relation between PEFR and WC either in the combined or categorical data for the genders.[8,23]

Various studies have described the physiological mechanisms behind the adverse effect of obesity on pulmonary functions. It has been evident that various metabolically active and pro-inflammatory substances, including leptin and resistin, are released from adipose tissues in an enormous amount in obesity. Leptin and resistin will cause activation of nuclear factor-kB (NF-kB) and upregulation of tumour necrosis factor-alpha (TNF-α) responsible for neutrophilic airway inflammation and deterioration in the lung function.[26]

It is recommended that obesity parameters and lung functions of the most vulnerable younger subjects should be assessed timely to avoid the hazardous consequence of obesity and pulmonary dysfunction, and to improve overall health and QOL.

The present study had limitations as it was conducted at a single centre the sample only comprised medical students. Furthermore, due to its small sample size, the study could not analyse data separately for gender and could not judge the impact of adiposity parameters on PEFR separately for males and females. As such, the findings are not generalisable.

The current study has its strengths as well, like using a strict protocol for measuring PEFR of the participants and proper data analysis with correct interpretation of results that were often in line with previous findings.

Conclusion

PEFR increased with an increase in BH, BMI, WC and PBF in healthy young subjects, reflecting positive association of adiposity parameters with PEFR. However, PEFR was not significantly associated with WHR and BW of the participants.

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Conflict of Interest: None.

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References

1. Jiang XQ, Mei XD, Feng D. Air pollution and chronic airway diseases: what should people know and do? J Thorac Dis. 2016; 8:E31-40.
2. Ferreira MS, Marson FAL, Wolf VLW, Ribeiro JD, Mendes RT. Lung function in obese children and adolescents without respiratory disease: a systematic review. BMC Pulm Med. 2020; 20:281.
3. Global Initiative for Chronic Obstructive Lung Disease (GOLD). Global strategy for the diagnosis, management, and Prevention of chronic obstructive lung diseases (GOLD). 2018 report. [Online] [Cited 2020 December 2]. https://goldcopd.org/wp-content/uploads/2017/11/GOLD-2018-v6.0-FINAL-revised-20-

Nov_WMS.pdf.
4. Çolak Y, Afzal S, Nordestgaard BG, Vestbo J, Lange P. Prognosis of asymptomatic and symptomatic, undiagnosed COPD in the general population in Denmark: a prospective cohort study.Lancet Respir Med. 2017; 5:426-34.
5. Mehta B, Bhandari B, Singhal A, Mavai M, Dutt N, RaghavN.Screening asymptomatic school children for early asthma by determining airway narrowing through peak expiratory flow rate measurement. J Educ Health Promot.2020; 9: 72.
6. Sandhu PK, Bajaj D, Mehta K. Correlation of peak expiratory flow rate with age and anthropometric parameters in elderly (> 65 years). Nat J Physiol Pharm Pharmacol. 2016; 6:89-92.
7. Manibpel SA, Trinidad T. Accuracy of peak expiratory flow rate: height ratio (PEFR/HT2) measured by portable device in predicting low FEV1/FVC in patients undergoing spirometry at Santo Tomas hospital. Respirol. 2018; 23:246-7.
8. Ijaz A, Bashir I, Ikhlaq A, Ijaz F, Aftab RK, Zia R. Markers of Adiposity, and Anthropometric Measures in Medical Students in Pakistan. Cureus. 2020; 12: e12408.
9. Kwon H, Kim D, Kim JS. Body fat distribution and the risk of incident metabolic syndrome: a longitudinal cohort study. Sci Rep. 2017; 7:10955.
10. Asghar A, Shah AM, Hussain AA, Tahir A, Asghar H. Frequency of Pre-obesity and Obesity in Medical Students of Karachi and the Predisposing Lifestyle Habits. Cureus. 2019; 11:e3948.
11. Kumari S, Deo AK, Upadhyay MK. Association of BMI, Peak expiratory flow rate and sympathetic reactivity in youth. Indian J Pharm Pharmacol.2019; 6:33-6.
12. Arsh A, Ali A, Ullah I, Darain H, Khan A, Zaidi MU, et al. Body mass index in medical students and its association with gender and academic year. Pak J Physiol. 2017; 13:18-21.
13. open epi sample size calculator. [Online] [Cited 2020 Febuary 5]. Available from: URL: https://www.openepi.com/SampleSize/SSPropor.htm.
14. World Health Organization. Regional Office for the Western Pacific . The Asia-Pacific perspective : redefining obesity and its treatment. Sydney:HealthCommunications.Australia. [Online] [Cited 2022 January 17]. Available from: URL: https://apps.who.int/iris/handle/10665/206936
15. World Health Organization. Waist circumference and waist-hip ratio: report of a WHO expert consultation. [Online] [Cited 2022 January 17]. Available from: URL: https://apps.who.int/iris/bitstream/handle/10665/44583/?sequence=1
16. Dar MA, Jain N, Bhat SA, Garg N. Association of peak expiratory flow rate with obese and overweight individuals. Int J Com Med Public Health. 2020; 7:4811-6.
17. Rai RH, Gupta S, Mohd A. Relationship of Peak Expiratory Flow Rate with Waist Circumference, Hip Circumference, and Waist-to-Hip Ratio in Young Adults. Ann Nat Acad Med Sci. 2020; 56:26-9.
18. Firdous J, Nabila N , Haziqah N , Nisa NK , Nurhannah , jaganathan R. Association of peak expiratory flow rate with age and height among malaysian adults. Asian J Med Health Sci. 2020; 3:61-8.
19. Atta K, Zia S, Jabeen F. Impact of Anthropometric Parameters on Peak Expiratory Flow Rate. J Aziz Fatm Med Den Coll.2019; 1:63-6.
20. Prasoona GR, Nightigale SS. Study of correlation between bmi and pefr rate in rayalaseema population. Int J Intg Med Sci. 2019; 6:780-84.
21. Patil SR, Mehta A. Comparison of peak expiratory flow rate in obese and non-obese women. Int J Health Sci Res. 2019; 9:39-45.
22. Chen YY, Kao TW, Fang WH , Wang CC, Chang YW, Yang HF, et al. Body Fat Percentage in Relation to Lung Function in Individuals with Normal Weight Obesity. Sci Rep. 2019; 9:3066.
23. Aryana I, Nugraha K, Putra A, Kusumawardani I, Kuswardhani R, Astika N, et al. The Association between Central Obesity and Peak Expiratory Flow Rate (PEFR) in Elderly at Pedawa Village, Buleleng, Bali, Indonesia. EPH Int J Med Health Sci. 6063. 2018; 4:1-20.
24. Sutradhar B, Choudhuri D, Hore S. Relative influence of overall and central body adiposity on lung function and development of lung function predictive model for adolescents in Tripura. Med J DY Patil Vidyapeeth. 2021; 14:415-2.
25. Alipour B, Hosseini SZ, Sharifi A, Ansarin K. Influence of anthropometric measurements in lung function in patients with asthma. Int J Prev Med.2015; 6:50.
26. Yuan Y, Ran N, Xiong L, Wang G, Guan X, Wang Z, et al. Obesity-Related Asthma: Immune Regulation and Potential Targeted Therapies. J Immunol Res. 2018; 2018:1943497.