Original Article

Correlation between Body Composition and Peak Expiratory Flow Rate in First-Year Medical Students of Diponegoro University

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Abstract

Background: Peak expiratory flow rate (PEFR) is one part of pulmonary ventilation parameters which affects the quality of life. The objective of this study was to determine the correlation between body mass index (BMI) and waist circumference (WC) with PEFR in first-year medical undergraduates of Diponegoro University.

Methods: This is a cross-sectional study that measures BMI, WC, and PEFR of 169 first-year medical students of Diponegoro University. BMI, WC, and PEFR were assessed using a digital scale, measuring tape, and Mini-Wright peak flow meter (PFM), respectively. Spearman test is used for bivariate analysis, whereas the multiple regression method is used for multivariate analysis. The results are considered significant if P<0,05 for bivariate and F<0,05 for multivariate analysis. For statistical analysis, IBM SPSS Statistics 26.0 Software was used.

Results: Most of the subjects had normal BMI with a mean value of 23,38 (± 0,36) kg/m^2. As many as 71,6% of the subjects had normal WC. BMI demonstrated a significant positive Spearman's correlation (P=0,001) with a weak strength (R=0,260) towards PEFR. As for BMI, WC also demonstrated a significant positive correlation (P<0,001) with a weak strength (R=0,342) towards PEFR. Simultaneously, both BMI and WC had a significant positive correlation (F<0,001) with a weak strength (R=0,361) towards PEFR.

Conclusion: This study concludes that higher BMI and WC values coincide with higher PEFR values.

Keywords: body mass index, waist circumference, peak expiratory flow rate, obesity

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INTRODUCTION

PEFR is among the lung ventilation parameters that determine the quality of life (Hall, 2016; Roberts and Mapel, 2012). PEFR is measured by previously asking the patient to inhale a deep breath, then exhale suddenly and powerfully into an instrument called mini-Wright PFM (Adeniyi and Erhabor, 2011; Myatt, 2017). The result is expressed in L/minute and it indicates the resistance of small respiratory airways (Adeniyi and Erhabor, 2011; Hall, 2016; Mehta *et al.*, 2016; Tian *et al.*, 2012). Thus, a decrease in PEFR represents an airway obstruction, such as in those with asthma and chronic obstructive pulmonary disease (Dancer and Thickett, 2012; Mehta *et al.*, 2016; Myatt, 2017; Tian *et al.*, 2012). PFM provides a more convenient and practical alternative for assessing airway obstruction compared to a spirometer which is less available and requires a professional worker to operate it (Myatt, 2017; Scottish Intercollegiate Guidelines Network and British Thoracic Society, 2019; Tian *et al.*, 2012). Besides obstruction, a decrease in PEFR also occurs in patients with reduced lung volume, such as those with pleural effusion and respiratory muscle weakness (Myatt, 2017).

Physiologically, PEFR is well-known to be affected by age, gender, and height (Adeniyi and Erhabor, 2011). Previous studies have demonstrated that PEFR can also be influenced by body weight, body surface area, BMI, WC, antioxidant and alcohol consumption, and smoking habits. BMI has an inverse relationship with PEFR, whether it is significant or not (Jones and Nzekwu, 2006; Kaur *et al.*, 2013; Kumar *et al.*, 2016; Mungreiphy *et al.*, 2012; Saxena *et al.*, 2009; Shenoy *et al.*, 2014). Overweight and obese individuals, who have higher BMI values than the normal population, have their thoracic cavity expansion restricted due to the excessive amount of fat layers. In android obesity, the upward displacement of the diaphragm also decreases lung volume. The decrease in maximum lung volume before expiration increases airway resistance and decreases PEFR (Koenig, 2001; Rabec *et al.*, 2011; Salome *et al.*, 2010). This relationship is seen in the flow-volume curve between PEFR and functional residual capacity, which describes that reduced lung volume correlates with reduced PEFR (Salome *et al.*, 2010; Wehrmeister *et al.*, 2012). PEFR can also be negatively affected by WC, an indicator of central obesity, by restricting diaphragm and lung expansion (Koenig, 2001; Salome *et al.*, 2010). In addition, WC has been shown as a more reliable marker of PEFR reduction than BMI (Saxena *et al.*, 2009).

Both WC and BMI are convenient means of measuring body composition (Ackland *et al.*, 2012; Wells and Fewtrell, 2006). BMI represents adiposity with high specificity, but it cannot measure body fat distribution (Okorodudu *et al.*, 2010; Pasco *et al.*, 2012). This pitfall is overcome by taking WC into account as a reliable indicator of visceral adiposity (Berker *et al.*, 2010; Wells and Fewtrell, 2006).

The negative effects of obesity towards PEFR are deteriorated by the fact that the global prevalence of obesity in 2016 had increased nearly three times compared with 1975, as showed by the surveillance conducted by the World Health Organization (WHO) (Levesque, 2011). In Indonesia, Riset Kesehatan Dasar (Riskesdas) held in 2018 demonstrated that as many as 13,6% and 21,8% of its adult population are overweight and obese, respectively. Both values are higher than those in 2007 and 2013. Riskesdas 2018 also classified 31% of Indonesian adults >15 years old for having central obesity, and the value is also higher than that in 2007 and 2013 (*Hasil Utama Riskesdas 2018*, 2018).

Considering the increased prevalence of obesity and its related pulmonary complications, this study aims at determining the relationship between body composition parameters, which are BMI and WC, towards PEFR.

METHODS

This cross-sectional study was held from October 5th to 8th, 2020, in Faculty of Medicine, Diponegoro University, Semarang. This study measures the BMI, WC, and PEFR of 169 first-year medical students of Diponegoro University. Subjects were taken using the purposive sampling method and had previously given informed consent using *Google Form* as an online platform. BMI, WC, and PEFR were assessed using *Omron* digital scale, measuring tape, and Mini-Wright PFM, respectively. BMI was classified using WHO criteria for Asian population into underweight (BMI <18,5 kg/m^2), normal (BMI 18,5 to 22,9 kg/m^2), overweight (BMI 23,0 to 27,5 kg/m^2), and obese (BMI >27,5 kg/m^2) (Satyanarayana *et al.*, 2013). WC is classified using International Diabetes Foundation criteria for Asian population into normal (≤90 cm for men, ≤80 cm for women), and central obesity (>90 cm for men, >80 cm for women) (World Health Organization, 2011). PEFR was estimated by firstly requesting that the subject breathes in a full breath before blowing it strongly into the PFM. The best value was taken from three consecutive measurements (Adeniyi and Erhabor, 2011; Myatt, 2017). Ethical clearance was acquired from the Medical and Health Research Ethics Commission, Faculty of Medicine, Diponegoro University No. 49/EC/KEPK/FK-UNDIP/IV/2020.

IBM SPSS Statistics 26.0 Software is used for statistical analysis and the Kolmogorov-Smirnov test is used to assess the data distribution's normality. Pearson test is used when the data distribute normally, while the Spearman test is used if the data do not show normal distribution. Multiple regression method is used for multivariate analysis. The results are considered significant if P<0,05 for bivariate and F<0,05 for multivariate analysis.

RESULTS

We collected 169 first-year medical students of Diponegoro University as subjects for this study. The characteristic of the subjects is shown in Table 1. There were 64 men and 105 women. The age range is from 17 to 21 years old, with the largest proportion (45,0%) coming from 19-year olds. The mean BMI was 23,38 kg/m^2 and the values ranged from 16,00 to 38,90 kg/m^2. As many as 71,6% of the subjects in this study show normal WC. The mean PEFR was 444,97 L/minute.

Table 2. Data distribution and correlation strength between BMI, WC, and PEFR

Variable	Spearman's P value	Spearman's correlation coefficient (R)
BMI PEFR	0,001*	0,260
WC PEFR	<0,001*	0,342

*Significant correlation

Table 3. Simultaneous correlation strength between BMI and WC towards PEFR

F value (multiple regression)	R value	Correlation strength
<0,001*	0,361	Weak

Table 1. Characteristic of the subjects

Characteristic		N (%)	Mean ± SD; Median (Min – Max)
Gender	Men	64 (37,9)	-
	Women	105 (62,1)	
	Total	169 (100)	
Age (years)	17	5 (3,0)	18,80 ± 0,63; 19,00 (17 – 21)
	18	58 (34,3)	
	19	76 (45,0)	
	20	26 (15,4)	
	21	4 (12,4)	
BMI (kg/m^2)	Underweight	20 (11,8)	23,38 ± 0,36; 22,70 (16,00 – 38,90)
	Normal	69 (40,8)	
	Overweight	46 (27,2)	
	Obese	34 (20,1)	
WC (cm)	Normal	121 (71,6)	79,93 ± 0,89; 78,00 (62,0 – 120,0)
	Central obesity	48 (28,4)	
PEFR (L/minute)	-	-	444,97 ± 8,80; 410,00 (155 – 740)

Min = Minimum; Max = Maximum; N = Sum; SD = Standard deviation

Kolmogorov-Smirnov normality test for BMI, WC, and PEFR do not show normal data distributions. Thus, all of them are directed to Spearman's test to determine their intervariable relationships. BMI shows a significant positive Spearman's correlation (P=0,001) with weak strength (R=0,260) towards PEFR (Table 2). As for BMI, WC also shows a significant positive correlation (P<0,001) with weak strength (R=0,342) towards PEFR (Table 2). Simultaneously, BMI and WC have a significant positive correlation (F<0,001) with weak strength (R=0,361) towards PEFR (Table 3).

DISCUSSION ← Arial 10pt; bold; UPPERCASE; 1,39 spasi

This study demonstrated a positive correlation between each BMI and WC towards PEFR with both p values of <0.001. These outcomes contradicted past studies which showed that a rise in BMI values is related to reduced PEFR levels (Jones and Nzekwu, 2006; Kaur *et al.*, 2013; Kumar *et al.*, 2016; Mungreiphy *et al.*, 2012; Saxena *et al.*, 2009; Shenoy *et al.*, 2014). There was a study that showed no significant correlation between them (Ilham Wahyu, 2017). We found two 22 studies conducted by Dharamshi and Archana that demonstrated a positive correlation between BMI and PEFR, as of this study. However, Dharamshi explained that the lack of overweight and obese samples contributed to the difference in his result with previous researches (Dharamshi *et al.*, 2015). That case is the same as this study, where most of the subjects have normal BMI and WC. Only 12% and 28% of the subjects are underweight and have central obesity, respectively. Although the study by Archana showed a positive correlation in general, more specific analyses on each of the BMI categories showed that BMI negatively correlates with PEFR when the BMI exceeded +2 SD. This implied that an increase in BMI starts to reduce PEFR in overweight people (Nepal, 2019).

As for BMI, this study also showed that WC had a positive significant correlation with PEFR which differs from previous studies. Rai showed a negative correlation between WC and PEFR on men subjects (Koenig, 2001; Regitz-Zagrosek *et al.*, 2006). A meta-analysis comprising 10 studies that assessed the relationship between WC and lung function exhibited an negative correlation between WC and forced expiratory volume in 1 second (FEV_1). Since FEV_1 is the expiration rate on the first second, it represents the maximum expiratory flow and thus is strongly associated with PEFR (Llewellin *et al.*, 2002; Shin *et al.*, 2005; Wehrmeister *et al.*, 2012). Those studies are consistent with the idea that increased WC restricts lung expansion (Berker *et al.*, 2010; Koenig, 2001; Lavie *et al.*, 2012; Okorodudu *et al.*, 2010; Pasco *et al.*, 2012; Salome *et al.*, 2010). Others showed no significant correlation, implying that WC is an independent factor of PEFR (Aryana *et al.*, 2018; Saxena *et al.*, 2011). The positive significant correlation between BMI and WC towards PEFR in our study may be explained by the greater number of subjects with normal BMI and WC in comparison to those with overweight and obesity.

LIMITATION

A lot of contradictions with the previous studies may also stem from the fact that this study was held during the coronavirus disease 2019 global pandemic, where activities inside the faculty were heavily restricted. Therefore, several measurements such as WC and body height for calculating BMI were done by the subjects themselves without direct supervision. Although the procedure had been provided online, errors were still possible and may affect the final result of this study. PEFR was measured on the spot and the subjects had been told how to use the PFM. However, it was still possible that they did not inhale a deep breath before exhaling or did not exhale powerfully. Besides the aforementioned technical and procedural problems, an even sample distribution for each of the BMI or WC categories is required to enhance the validity of the data. This can be achieved by increasing the sample size. Other variables such as body weight, body surface area, and alcohol consumption should also be taken into account to enhance the validity of the results.

CONCLUSION

Higher BMI and WC values coincide with higher PEFR values. Studies involving more variables, including those related to pulmonary ventilation such as FEV_1, are required to confirm the validity of this study.

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None.

Conflict of Interest

The authors declare no conflict of interest.

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