



# 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 of the pulmonary ventilation parameters that affects quality of life. PEFR is known to be negatively affected by high body mass index (BMI) and waist circumference (WC). This study aimed to determine the correlation of BMI and WC with PEFR in first-year medical undergraduates at Diponegoro University.

**Methods:** This was a cross-sectional study held from October 5<sup>th</sup> to October 8<sup>th</sup>, 2020, which measured the BMI, WC, and PEFR of 169 first-year medical students at Diponegoro University. The BMI, WC, and PEFR were assessed using a digital scale, measuring tape, and Mini-Wright Peak Flow Meter (PFM), respectively. Spearman test was used for bivariate analysis, whereas the multiple regression method was used for multivariate analysis. The results are considered significant if  $P < 0,05$  for bivariate and  $F < 0,05$  for multivariate analysis. The IBM SPSS Statistics 26.0 Software was used for statistical analysis.

**Results:** Most of the subjects had normal BMI, with a mean value of 23.38 ( $\pm 0.36$ ) kg/m<sup>2</sup>. As many as 71.6% of the subjects had normal WC. There was a correlation between BMI and PEFR ( $P = 0.001$ ) with a weak strength ( $R = 0.260$ ). 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:** Higher BMI and WC values coincided with higher PEFR values.

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

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## INTRODUCTION

Peak expiratory flow rate is among the lung ventilation parameters that determine the quality of life.<sup>1,2</sup> 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.<sup>3,4</sup> The result is expressed in L/minute and indicates the resistance of small respiratory airways.<sup>2,3,5,6</sup> Thus, a decrease in PEFR represents an airway obstruction, such as in those with asthma and chronic obstructive pulmonary disease (COPD).<sup>5–7</sup> 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.<sup>4,6,8</sup> Besides obstruction, a decrease in PEFR also occurs in patients with reduced lung volume, such as those with pleural effusion and respiratory muscle weakness.<sup>4</sup>

Physiologically, PEFR is well-known to be affected by age, gender, and height.<sup>3</sup> 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.<sup>9–13</sup> 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. 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.<sup>14–16</sup>

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.<sup>16,17</sup> PEFR can also be negatively affected by WC, an indicator of central

obesity, by restricting diaphragm and lung expansion.<sup>14,16</sup> In addition, WC is a more reliable marker of PEFR reduction than BMI.<sup>12</sup> Both WC and BMI are convenient means of measuring body composition.<sup>1,18</sup> BMI represents adiposity with high specificity, but it cannot measure body fat distribution.<sup>19,20</sup> This pitfall is overcome by taking WC into account as a reliable indicator of visceral adiposity.<sup>18,21</sup>

The negative effects of obesity on PEFR are deteriorated the fact that the global prevalence of obesity in 2016 increased nearly three times compared with 1975, as shown by the surveillance conducted by the World Health Organization (WHO).<sup>22</sup> In Indonesia, *Riset Kesehatan Dasar* (Riskesdas) held in 2018 demonstrated that as many as 13.6% and 21.8% of its adult population were overweight and obese, respectively. Both values were higher than those in 2007 and 2013. Riskesdas 2018 also classified 31% of Indonesian adults >15 years old as having central obesity, and the value was also higher than that in 2007 and 2013.<sup>23</sup>

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

**METHODS**

This cross-sectional study was held from October 5<sup>th</sup> to October 8<sup>th</sup>, 2020, in the Faculty of Medicine, Diponegoro University, Semarang. This study measured the BMI, WC, and PEFR of 169 first-year medical students at Diponegoro University. Subjects were taken using the consecutive sampling method and had previously been asked to consent using *Google Forms* as an online platform. Male and female first-year medical students aged more than 16 who agreed to join the study were included. Subjects with prior or current COPD, current upper or lower respiratory tract infections, or those with a history of smoking were excluded.

The *Omron* digital scale, measuring tape, and Mini-Wright PFM were used to determine BMI, WC,

and PEFR, respectively. BMI was classified using WHO criteria for the Asian population into four categories: underweight (BMI <18.5 kg/m<sup>2</sup>), normal (BMI 18.5 to 22.9 kg/m<sup>2</sup>), overweight (BMI 23.0 to 27.5 kg/m<sup>2</sup>), and obese (BMI >27.5 kg/m<sup>2</sup>).<sup>24</sup> WC was classified using International Diabetes Foundation criteria for the Asian population into normal (≤90 cm for men, ≤80 cm for women), and central obesity (>90 cm for men, >80 cm for women).<sup>25</sup> PEFR was estimated by first requesting that the subject breathed in a full breath before blowing it strongly into the PFM. The best value was taken from three consecutive measurements.<sup>3,4</sup> 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 was used for statistical analysis and the Kolmogorov-Smirnov test was used to assess the data distribution's normality. The Pearson test was used when the data was distributed normally, whereas the Spearman test was used when the data was not normally distributed. For multivariate analysis, the multiple regression method was used. The results were considered significant if *P*<0,05 for bivariate analysis and *F*<0,05 for multivariate analysis.

**RESULTS**

We collected 169 first-year medical students from Diponegoro University as subjects for this study. The mean BMI was 23.38 kg/m<sup>2</sup>, and the values ranged from 16.00 to 38.90 kg/m<sup>2</sup>. As many as 71.6% of the subjects in this study show normal WC. The mean PEFR was 444.97 L/minute (Table 1).

Table 1. Characteristics of age, BMI, WC and PEFR of the subjects

Characteristic	Mean±SD	Median (Min–Max)
Age (years)	18.80±0.63	19.00 (17–21)
BMI (kg/m <sup>2</sup> )	23.38±0.36	22.70 (16.00–38.90)
WC (cm)	79.93±0.89	78.00 (62.0–120.0)
PEFR (L/minute)	444.97±8.80	410.00 (155–740)

Note: Min = Minimum; Max = Maximum; SD = Standard deviation

There were 64 men and 105 women. The age range was from 17 to 21 years old, with the largest proportion (45.0%) coming from 19-year-olds (Table 2).

Table 2. Characteristics of gender, age, BMI, and WC of the subjects

Characteristic	N (%)
Gender	
Men	64 (37.9%)
Women	105 (62.1%)
Age (years)	
17	5 (3.0%)
18	58 (34.3%)
19	76 (45.0%)
20	26 (15.4%)
21	4 (12.4%)
BMI (kg/m <sup>2</sup> )	
Underweight	20 (11.8%)
Normal	69 (40.8%)
Overweight	46 (27.2%)
Obese	34 (20.1%)
WC (cm)	
Normal	121 (71.6%)
Central obesity	48 (28.4%)
Total	169 (100.0%)

Note: N = Sum

Kolmogorov-Smirnov normality test for BMI, WC, and PEFR did not show normal data distributions. Thus, all of them were directed to Spearman's test to determine their intervariable relationships. BMI had a significant positive Spearman's correlation ( $P=0.001$ ) with weak strength ( $R=0.260$ ) towards PEFR. As for BMI, WC also showed a significant positive correlation ( $P<0.001$ ) with weak strength ( $R=0.342$ ) towards PEFR (Table 3).

Table 3. Bivariate analysis between BMI, WC, and PEFR

Variable	P	Correlation coefficient (R)
BMI PEFR	0.001 <sup>a</sup>	0.260
WC PEFR	<0.001 <sup>a</sup>	0.342

Note: <sup>a</sup>Significant correlation with Spearman test if  $P<0.05$

Simultaneously, both BMI and WC had a significant positive correlation ( $F<0.001$ ) with weak strength ( $R=0.361$ ) towards PEFR (Table 4).

Table 4. Multivariate analysis between BMI, WC, and PEFR

F (multiple regression)	R	Correlation strength
<0.001 <sup>a</sup>	0.361	Weak

Note: <sup>a</sup>Significant correlation if  $F<0.05$

## DISCUSSION

This study demonstrated a positive correlation between each BMI and WC towards PEFR with both

$P<0.001$ . These outcomes contradicted past studies, which showed that a rise in BMI values was related to reduced PEFR levels.<sup>9-13,26</sup> There was a study that showed no significant correlation between them.<sup>27</sup> We found two 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.<sup>28</sup>

That case is the same as this study, where most of the subjects had normal BMI and WC. Only 12% and 28% of the subjects were underweight and had central obesity, respectively. Although the study by Archana showed a positive correlation in general, more specific analyses of each of the BMI categories showed that BMI negatively correlated with PEFR when the BMI exceeded +2 SD. This implied that an increase in BMI starts to reduce PEFR in overweight people.<sup>29</sup>

As for BMI, this study also showed that WC had a positive and significant correlation with PEFR which differed from previous studies. Rai showed a negative correlation between WC and PEFR in male subjects.<sup>14,30</sup> A meta-analysis comprising 10 studies that assessed the correlation between WC and lung function exhibited a negative correlation between WC and forced expiratory volume in 1 second (FEV<sub>1</sub>). Since FEV<sub>1</sub> is the expiration rate on the first second, it represents the maximum expiratory flow and thus is strongly associated with PEFR.<sup>17,31,32</sup> Those studies are consistent with the idea that increased WC restricts lung expansion.<sup>14,16,19-21,33</sup>

Others showed no significant correlation, implying that WC is an independent factor of PEFR.<sup>34,35</sup> The significant positive 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<sub>1</sub>, are required to confirm the validity of this study.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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