EPH - International Journal of Medical and Health Science
ISSN (Online): 2456-6063
Volume 03 Issue 01 March 2017

DOI: https://doi.org/10.53555/eijmhs.v4i2.24

THE ASSOCIATION BETWEEN CENTRAL OBESITY AND PEAK EXPIRATORY FLOW RATE (PEFR) IN ELDERLY AT PEDAWA VILLAGE, BULELENG, BALI, INDONESIA

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Abstract: -

Objective. *To determine the association between central obesity and peak expiratory flow rate (PEFR).*
Methods. *A cross-sectional analytical study was carried out in Pedawa village, Buleleng District, Bali Province, Indonesia, on August 13, 2016. A total of 117 elderly subjects above 60 years old were included in the study to assess the association between central obesity and PEFR, but only 90 subjects met the inclusion criteria of this study.*
Results. *Regardless of sex, using backward multiple regression analysis, fat has a negative correlation (β = -0.376) against PEFR while the visceral fat (β = 0.440) and height (β = 0.274) were positively correlated. Specifically in elderly with underweight and normal BMI, variables that were positively correlated with PEFR on multivariate analysis including visceral fat (β = 0.450) and height (β = 0.315), while fat had a negative correlation (β = -0.309). In elderly with overweight and obesity BMI, fat was the only variable that significantly correlated with PEFR on bivariate analysis (r = - 0.723, p = 0.004), and no other variables were eligible for inclusion in the multivariate analysis.*
Conclusions. *This study found that, the percentage of visceral fat had a positive correlation with PEFR in the elderly with underweight and normal BMI, while the percentage of fat had a negative correlation with PEFR in the elderly with overweight and obesity BMI. This study didn't find any association between waist circumference and PEFR.*

Key words: *elderly, central obesity, PEFR.*

BACKGROUND: -

Obesity is currently a health problem with increasing incidence in the elderly population.[1-3] Current cross-sectional and longitudinal studies indicate changes in fat and muscle composition related to age, such as tendency of being obese, increasing amount of visceral fat, and decrease in skeletal muscle. Lung function was also altered with age as age-related lung function decrement is associated with increasing mortality rate.[1] Lung function is orchestrated by a complex interaction between the lung, chest wall and respiratory muscle. Hence, age-related fat accumulation will alter these interaction.[4] Changes in lung function due to increased body weight include small airway dysfunction and expiratory airflow limitation, alteration in respiratory mechanical, decreased chest wall and lung compliance, decreased endurance and respiratory muscle strength, decreased pulmonary gas exchange, lower respiratory control, as well as limited exercise capacity.[4] It has been reported that respiratory muscle strength and lung function related to body weight and lean body mass in patients with chronic obstructive pulmonary disease (COPD) and central fat distribution have negative associations with lung function in healthy adults.[1] This may be due to fat distribution in the abdominal cavity which inhibits the diaphragm movement thus affecting lung function.[5] Peak expiratory flow rate (PEFR) is a method often used to monitor lung function. PEFR is the maximum expiratory rate can be attained by a person, started with the maximum pulmonary inspiration, in liters/minute.[3,4,7,8-10] PEFR is frequently used as a screening tool various studies and can be operated by an untrained individual by using a mini-wright peak flow meter.[8,11] This type of lung function measurements is relatively easy and inexpensive, especially in epidemiological studies of lung function in elderly comparing to another type of measurement and its value has been proven to be a significant predictor of 5-year mortality in elderly.[1,7-9,12]
Nowadays, only few studies investigate the association between body fat composition, fat distribution, and lung function.[1] in this study, authors aim to investigate the association between central obesity (waist circumference and the percentage of viceral fat by bioelectrical impedance analysis or BIA) with PEFR. The significant association of waist circumference (WC), visceral fat, and PEFR were defined by controling various confounding variables. As we know, lung function has been proven to be a significant predictor of 5-year mortality in elderly, thus the influence of globally increasing central obesity incidence against lung function will be very important to know. Only few studies have investigated association of these variables (especially visceral fat) and PEFR in the elderly in Indonesia, thus the result of this study also could serve as a compass for similar study in Indonesia and Asia.

METHOD

Study Design

This study used a cross-sectional analytic design conducted in Pedawa village, Buleleng district, Bali province, Indonesia, on August 13, 2016.

Sample

Subject recruitment was conducted by invitation to all elderly above 60 years old residing in Pedawa village. Afterwards, they were gathered in the hall where informed consent was obtained and those who agreed were examined. Subjects were included with consecutive sampling method but those with history of asthma, tuberculosis, long period of cough, and smoking were excluded. From the 117 elderly who underwent the history taking and physical examination, 90 subjects were included in this study.

Data Collection

Data was collected through history taking, general physical examination, anthropometry, and PEFR examination. Data collection was conducted by authors who are all certified medical doctors. All process was carried out on the same day at specified location.

StudyVariable

Waist circumference and visceral fat percentage was the independent variable, PEFR was the dependent variable. Confounding variable in this study include weight, height based on knee height, body mass index (BMI), and total body fat percentage (fat).

Anthropometry

Anthropometry examination conducted in this study included body weight, height based on knee height, BMI and WC measurement. Body weight was measured using scales, stated in kilograms (kg). Height was measured from knee height then converted with chumlea knee height formula, stated in centimeters (cm). Special tool was used in measuring knee height and subjects were in a sitting position. Measurements carried out on the subject left leg between the tibia to the femur at 90° angle. The tool was placed between the heel approximately five cm at proximal patella above femur condyle. Scale reading is done within 0.1 of accuracy. Results (centimetres) were converted into the height using the chumlea formula, namely: [13, 14]

- Height in man = 64.19 - (0.04 x age in years) + (2.02 x knee height in cm)
- Height in woman = 84.88 - (0.24 x age in years) + (1.83 x knee height in cm)

BMI was calculated with quetelet formula where weight (in kilograms) divided by the measurement results of height (in meters) which has been squared.[4] BMI was classified according to WHO criteria include underweight (BMI <18.5), normal (18.5 <BMI <24.9), overweight (BMI ≥ 25), and obesity (BMI ≥ 30).[15]

WC was measured using a cloth meter. WC measurement technique was based on the WHO protocol where metered looped at the midpoint of the imaginary line between the lower border of the last costae and the topiliac crest.[15] An imaginary line mentioned was the mid-axillary line. Referring to the International Diabetes Federation (IDF) consensus, WC value (specific for South Asians ethnic) are said to be high or central obesity if more than or equal to 90 cm for men and more than or equal to 80 cm for women. Both cut off was selected based on the diagnosis of central obesity in metabolic syndrome.[16]

Fat and Visceral fat
Visceral fat and fat percentage was obtained by BIA analyzer. This was done in a standing position and the tool will automatically calculate visceral fat and fat percentage.
PEFR
PEFR was expressed in liters per minute (L/min).[3,4,7-9] PEFR was measured with wright's mini peak flow meter in a standing position with pinched nostrils. After underwent adequate rest, subjects were asked to perform deep inspiration and expiration as strong as possible into the instrument. Three satisfactory results recorded by investigators, then the highest value was noted.
Statistic analysis
Data analysis used SPSS version 16. Univariate analysis is used to present the frequency and percentage of categorical variables. The mean, median, and standard deviation were used to present the numeric variables. Independent-sample T-test was used to compare numerical variables between the 2 groups. One way ANOVA was used to compare variables used numerical more than 2 groups. Confidence Interval (CI) was CI 95%. P value <0.05 was categorized as statistically significant. Bivariate correlation coefficient (r) was used to measure the strength of the correlation among numerical variables. Backward multiple regression analysis was used to test the effects of multiple variables (age, weight, height, WC, BMI, fat percentage and visceral fat percentage) to PEFR. Standardized coefficient beta (β) is used to measure the strength of the correlation on Backward multiple regression analysis.

Ethics approval
Ethics approval was obtained from the Ethics Committee for Research and Development Unit, Faculty of Medicine, University of Udayana/Sanglah General Hospital, Denpasar, Bali..

RESULTS
3.1 Population Study Characteristic
A total of 90 elderly participated in this study. Table 1 describes the characteristics of the study sample. The highest PEFR value was 450 L/min and the lowest was 110 L/min. Sample consisted of 32 male (35.6%) and 58 female (64.4%). Of all samples, 28.9% belong to the central obesity, central obesity percentage specific to sex, male and female are respectively 18.8% and 34.5%. Based on BMI values of all samples, 45.6% was classified as underweight, 38.9% normal, 13.3% overweight and 2.2% obese. Specific in male, 37.5% of the subjects classified as underweight, 46.9% normal, 12.5% overweight and 3.1% obese. In female subjects, 50% was classified as underweight, 34.5% normal, 13.8% overweight and 1.7% obese.

3.2 The PEFR mean difference by sex and age category
There are significant differences between the mean PEFR between male and female with a mean difference 0.1598 (CI: 0.10959 to 0.21002, p< 0.001). This study also classified subject's age into three categories, namely 60-69 years, 70-79 years, and 80-97 years of age. Using one way anova test, there was no significant difference in PEFR of those three age categories for each sex (p = 0.117). Separately, we then compare the PEFR mean in those three age categories for each sex. The result was not significant (p = 0.073) in male, whereas in female, it was significant (p = 0.006). In female, PEFR values differ significantly between the age category of 60-69 years and 70-79 years (CI: 0.0432 to 0.1774, p = 0.002). Meanwhile, there were no significant differences between 60-69 years and 80-97 years category (CI: -0,0222- 0.1435, p = 0.148), as well as between the age category of 70-79 years with 80-97 years (CI: -0,1415-0,0421, p = 0.283).

3.3 The PEFR mean difference by WC and BMI
This study compared the mean PEFR sample group between no central obesity group with central obesity group. Using independent-samples T test, there was no significant differences found in PEFR among those groups (CI: -0,09371-0,03358, p = 0.350). Specifically in the age category of 60-69 years, there was no significant differences between the mean value of PEFR between no central obesity and central obesity group (CI: -0,12266-0,03165, p = 0.241). PEFR mean difference between those two groups was also found not significant in subjects of the age category of 70-79 years (CI: -0,17995-0,15053, p = 0.855) and age 80-97 years (CI: -0,09124-0 , 21 928, p = 0.395). This study also found no significant difference between mean PEFR among these four BMI categories group of underweight, normal, overweight, and obese (p = 0.223). PEFR mean difference is not significant between BMI categories in the 60-69 age category (p = 0.386), age 70-79 (p = 0.330), age 80-97 (p = 0.760).

3.4 The correlation between age, weight, height, WC, BMI, fat, and visceral fat with PEFR on all sex.
A significant positive correlations with PEFR was found in weight (r = 0.345, p = 0.001), height (r = 0.381, p< 0.001), BMI (r = 0.228, p = 0.031), visceral fat (r = 0.285 , p = 0.007). While the age, WC, and fat variables did not correlate significantly with PEFR on bivariate analysis. The different results were obtained with multivariate analysis. We tested the association of several variables that are eligible for multivariate analysis using backward multiple regression analysis with the p value < 0,25.[17] From the analysis, fat was negatively correlated (β = -0.376) to PEFR while the visceral fat (β = 0.440) and height (β = 0.274) were positively correlated (Table 2).

3.5 The correlation between age, weight, height, WC, BMI, fat, and visceral fat with PEFR in male.

Specific to male, a significant positive correlation with the bivariate analysis was found only in height variable ($r = 0.503$, $p = 0.003$), while the other variables showed no significant correlation (Table 3). These results are consistent with the multivariate analysis, which height also showed significant positive correlation with PEFR ($\beta = 0.503$) (Table 4).

3.6 The correlation between age, weight, height, WC, BMI, fat, and visceral fat with PEFR in female.

The bivariate analysis on a female subjects showed a significant positive correlation with PEFR in weight variable ($r = 0.333$, $p = 0.011$), BMI ($r = 0.307$, $p = 0.019$), and visceral fat ($r = 0.308$, $p = 0.019$). A significant negative correlation was found between age and PEFR variables ($r = -0.262$, $p = 0.047$) as stated in Table 5. After multivariate analysis, weight was the only variable that showed a significant correlation with PEFR ($\beta = 0.333$), as shown in Tabel 6.

3.7 The correlation between visceral fat and PEFR in the elderly with underweight and normal BMI.

Authors conducted a separate linear regression analysis specifically in elderly with underweight and normal BMI, regardless of the sex. Table 7 shows the results of the bivariate analysis. After multivariate analysis, visceral fat ($\beta = 0.450$) and height ($\beta = 0.315$) were positively correlated with PEFR, while fat showed a negative correlation ($\beta = -0.309$) as shown in Table 8. In the group of elderly people with overweight and obese, fat was the only variable that significantly correlated with PEFR on bivariate analysis ($r = -0.723$, $p = 0.004$), and no other variables were eligible for inclusion in the multivariate analysis thus liner regression analysis could not be performed.

DISCUSSION

Authors aim to determine the association of waist circumference, visceral fat and PEFR in the elderly. Regardless of sex and BMI, through multivariate analysis, our data suggested that visceral fat, fat, and height associated with PEFR in the elderly. Height were positively correlated with PEFR, which this finding was coherent with the study finding conducted by Kaur, *et al.*,[7,9] Seema, *et al.,*[11] and Mishra, *et al.*[18] This was most likely due to the great lung volume on the subjects. The airways development and expiratory muscle effort increases along with the height.[19] We found that the fat percentage was negatively correlated with PEFR, coherent with the study results by Kamal, *et al.*[20] Studies in India population indicated negative correlation between body fat and lung function (FEV1, PEFR) (p value <0.01). We suspected relationship between fat percentage and PEFR was facilitated by the increased level of leptin. Leptin is a 167-amino acid peptide predominantly produced by adipose tissue. Leptin is also produced by other tissues such as placenta, ovarian, mammary epithelium, bone marrow, and lymphoid tissue. People with obesity show higher leptin pulsation amplitude and higher concentrations than in people without obesity.[21] According to study conducted by Ostlund, *et al.*[22] leptin associated with fat percentage, while a study conducted by Dua, *et al.*[23] showed that leptin was an indicator of total body fat not visceral fat. Leptin was associated with PEFR based on a study conducted by Samra*, et al.*[24] in which leptin has a strong positive correlation to PEFR. Central fat distribution (visceral fat) is theoretically associated with decreased lung function through the mechanism of diaphragm inhibition into the abdominal cavity.[1] Our findings on the protective effects of visceral fat were found opposite to this theory. This study then tested the consistency of PEFR correlation with visceral fat in overweight and obesity elderly. Apparently only fat percentage was significantly correlated with PEFR (strong positive correlation) in this group. The positive correlation of visceral fat to PEFR consistently found in underweight and normal BMI group, with the moderate strength of correlation. In this group, the fat percentage has a weak negative correlation while the height has a weak positive correlation. Our study also analyzed the factors that affect PEFR sex-specific. In male, only height that have a correlation with PEFR with moderate positive correlation. Meanwhile in female, only weight correlated with PEFR with weak positive correlation. According to Malhotra, *et al.*[25] the heavier the person, the need for oxygen will increase. Increased oxygen demand must be met by a ventilation system, which will improve respiratory function and PEFR. The specific cause of the differences from sex analysis is still in question requiring further study. It is suspected this was due to the small number of samples that was analyzed specifically for each sex. our study found no link between age and PEFR. This result is in opposite to the studies conducted by Kaur, *et al.*,[7,9] which found that there was a negative correlation between age and PEFR. We only found the differences between the PEFR mean values significantly according to age in female, among 60-69 years of age category and 70-79 years group. We also found no association between BMI and PEFR in the multivariate analysis, which was in accordance with the results of a study conducted by Kaur, *et al.*[7] The association between BMI and PEFR was found only by the bivariate analysis. WC was also not associated with PEFR in our study. This finding was consistent with study results conducted by Saxena, *et al.*[26] in a young population, which found no significant correlation between WC and PEFR on multivariate analysis. The weakness of our study was the study subjects were limited to specific area in Pedawa village, Buleleng, Bali. We recommend further multi-center studies conducted in Bali and Indonesia. The study also did not consider the role of external air pollution in the study site, which can be a confounding variable. Authors also did not know the certain mechanisms underlying the protective effect of visceral fat to PEFR in the elderly with underweight and normal BMI, thus further study is required by the longitudinal method, larger number of samples, and more widely geographic coverage to ensure the consistency of the visceral fat role and the underlying mechanisms. Our study did not examine the association of visceral fat and PEFR in the elderly with normal and underweight specifically according to sex (male or female) due to the limited number of samples.

CONCLUSION

This study has identified factors that are significantly associated with PEFR in elderly. Our knowledge about these factors is important because lung function has been proven to be a significant predictor of 5-year mortality in elderly. This study found that, the percentage of visceral fat had a positive correlation with PEFR in the elderly with underweight and normal

BMI, while the percentage of fat had a negative correlation with PEFR in the elderly with overweight and obesity BMI. This study didn't find any association between waist circumference and PEFR.

STATEMENT

None of the authors in this study had conflicting interest to this study.

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TABLE

Table 1 Study Sample Characteristic*

	Value
Age (years)	69.34 ± 9.124
Body weight (kg)	50.39 ± 12.463
Height (cm)	160.49 ± 7.188
Waist Circumference (cm)	75.67 ± 1.405
Body Mass Index	19.54 ± 4.659
Fat (%)†	29.22 ± 8.08
Visceral fat (%)†	7.01 ± 5.936
PEFR (l/menit)‡	240

Mean ± SD

†Measured with BIA

‡*Median.* **PEFR data was not normally distributed thus presented in median data**

Table 2 Backward multiple regression analysis to body weight, height, WC, BMI, fat, and visceral fat as independent variable and PEFR as dependent variable in both sex.

	β	**p value**
Model 1		
Body weight (kg)	-1.475	0.289
Height (cm)	0.798	0.076
Waist Circumference (cm)	-0.143	0.413
Body Mass Index	1.682	0.188
Fat (%)	-0.424	0.000
Visceral fat (%)	0.369	0.055
Model 2		
Body weight (kg)	-1.773	0.186
Height (cm)	0.870	0.048
Body Mass Index	1.879	0.134
Fat (%)	-0.441	0.000
Visceral fat (%)	0.346	0.068
Model 3		
Height (cm)	0.306	0.002
Body Mass Index	0.238	0.165
Fat (%)	-0.396	0.000
Visceral fat (%)	0.248	0.155
Model 4*		
Height (cm)	0.274	0.004
Fat (%)	-0.376	0.001
Visceral fat (%)	0.440	0.000

***the result of multivariate analysis**

Table 3 Correlation between age, body weight, height, WC, BMI, fat, and visceral fat with PEFR in male.

	PEFR	**p value**
Age (years)	-0.242	0.183
Body weight (kg)	0.167	0.360
Height (cm)	0.503	0.003*
Waist Circumference (cm)	0.105	0.566
Body Mass Index	-0.004	0.984
Fat (%)	-0.259	0.153
Visceral fat (%)	0.155	0.396

* **significant, p value < 0,05**

Table 4 Backward multiple regression analysis to age, height, and fat as independent variable and PEFR as dependent variable in male.

	β	p value
Model 1		
Age (years)	-0.153	0.351
Height (cm)	0.437	0.014
Fat (%)	-0.142	0.393
Model 2		
Age (years)	-0.152	0.354
Height (cm)	0.474	0.006
Model 3*		
Height (cm)	0.503	0.003

***the result of multivariate analysis**

Table 5 Correlation between age, body weight, height, WC, BMI, fat, and visceral fat with PEFR in female.

	PEFR	p value
Age (years)	-0.262	0.047*
Body weight (kg)	0.333	0.011*
Height (cm)	0.129	0.335
Waist Circumference (cm)	0.190	0.153
Body Mass Index	0.307	0.019*
Fat (%)	0.191	0.151
Visceral fat (%)	0.308	0.019*

***significant, p value < 0,05**

Table 6 Backward multiple regression analysis with age, body weight, WC, BMI, fat, and visceral fat as independent variable and PEFR as dependent variable in female.

	β	p value
Model 1		
Age (years)	-0.123	0.431
Body weight (kg)	0.527	0.304
Waist Circumference (cm)	-0.249	0.310
Body Mass Index	-0.187	0.667
Fat (%)	-0.025	0.902
Visceral fat (%)	0.205	0.406
Model 2		
Age (years)	-0.130	0.358
Body weight (kg)	0.516	0.302
Waist Circumference (cm)	-0.248	0.308
Body Mass Index	-0.187	0.664
Visceral fat (%)	0.194	0.392
Model 3		
Age(years)	-0.136	0.334
Body weight (kg)	0.336	0.221
Waist Circumference (cm)	-0.232	0.330
Visceral fat (%)	0.177	0.423
Model 4		
Age(years)	-0.140 0.438	0.315
Body weight (kg)	-0.184	0.073
Waist Circumference (cm)		0.423
Model 5		
Age(years)	-0.172	0.200
Body weight (kg)	0.277	0.041

	β	p value
Model 6*		
Body weight (kg)	0.333	0.011

***the result of multivariate analysis**

Table 7 Correlation between age, body weight, height, WC, fat, and visceral fat with PEFR specific in elderly with underweight and normal BMI.

	PEFR	p value
Age (years)	-0.081	0.489
Body weight (kg)	0.466	0.000*
Height (cm)	0.422	0.000*
Waist Circumference	0.189	0.101

*** significant, p value < 0,05**

Table 8 Backward multiple regression analysis to body weight, height, WC, fat, and visceral fat as independent variable and PEFR as dependent variable, specific in elderly with underweight and normal BMI.

	β	p value
Model 1		
Body weight (kg)	0.353	0.038
Height (cm)	0.224	0.038
Waist Circumference (cm)	-0.233	0.111
Fat (%)	-0.281	0.008
Visceral fat (%)	0.357	0.012
Model 2		
Body weight (kg)	0.212	0.146
Height (cm)	0.247	0.023
Fat (%)	-0.316	0.003
Visceral fat (%)	0.315	0.024
Model 3*		
Height (cm)	0.315	0.002
Fat (%)	-0.309	0.003
Visceral fat (%)	0.450	0.000

***the result of multivariate analysis**