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# Correlation between body composition and bone mineral density in obese pre-menopausal women

Farah Hendara Ningrum[1*], Ignatius Riwanto[2], Hermina Sukmaningtyas[3], Kusworo Adi[4], Tjokorda Gde Dalem Pemayun[5], Antonius Gunawan Santoso[6], Rr. Lydia Purna Widyastuti Setjadiningrat Kuntjoro[7], Miftahul Jannah[8], Meita Hendrianingtyas[9]

[1]Doctoral Study Program of Medical and Health Science, Faculty of Medicine, Universitas Diponegoro, Semarang, Indonesia; farahhendara@fk.undip.ac.id (F.H.N.).
[2]Department of Surgeon , Faculty of Medicine, Universitas Diponegoro, Semarang, Indonesia.
[3]Department of Radiology, Faculty of Medicine, Universitas Diponegoro, Semarang, Indonesia.
[4]Department of Physics, Faculty of Science and Mathematics, Universitas Diponegoro, Semarang, Indonesia.
[5]Department of Internal Medicine, Faculty of Medicine, Universitas Diponegoro, Semarang, Indonesia.
[6,7]Department of Radiology, Faculty of Medicine,Universitas Diponegoro, Semarang, Indonesia.
[8]Department of Radiology, Dr. Kariadi General Hospital, Semarang, Indonesia.
[9]Department of Clinical Pathology, Universitas Diponegoro, Semarang, Indonesia.

**Abstract:** Obese condition which causes changes in body composition affect to very serious consequences on Bone Mineral Density (BMD). This study aims to analyze correlation between body composition that consist of lean mass, fat mass, and visceral fat rating with Bone Mineral Density. Cross-sectional study that conducted from June-December 2023 at Diponegoro National Hospital (RSND) Semarang. Body composition respondent was measured using Tanita Body Analyzer and bone mineral density respondent was analyzed using Dual X-ray absorptiometry (DXA) in Semarang Medical Center. Statistical Analysis for correlation in this study using Spearman Test. Total 100 respondent in this study was in obese condition with mean body mass index 33.08 ± 5.42 kg/m2. There was no significant correlation between lean mass and total fat mass with bone mineral density ($p>0.05$) but, viseral fat rating and bone mineral density having significant correlation with $p=0.021$ with weak correlation strength $r=0.230$. Positive correlation was found among body composition that consist of fat mass, lean mass, and visceral fat rating with bone mineral density but, significant correlation only found in visceral fat fat rating and bone mineral density ($p=0.021$).

***Keywords:*** *Body composition, Bone mineral density, Dual x-ray absorptiometry (DXA), Obesity.*

## 1. Introduction

Obesity becoming one of major global health problem that is not only found in developed countries but also developing countries like Indonesia. Prevalention of obesity increasing rapidly every year. Basic Health Survey (Riskesdas) in 2018 showed the prevalence of obesity among adults aged above 18 years old and above is 21.8%.[1] Prevalence of obesity in women is 29.8% compared to men 14.7%.

Obese condition can affect to very serious consequences on various organs and systems. Bones are one of the body organs that have a close correlation with obesity. Bone is a living tissue with metabolic functions. The size and shape of bones are accurately modeled and reshaped over a lifetime to ensure skeletal structure and integrity (Hou et al, 2020). Relationship between obesity and bone metabolism is still unclear. Some of studies showing that increased body weight has been considered a factor that increases bone mass and decreases risk of fracture (Hammoud et al, 2021). On the other hand, other studies tell that increasing evidence has been found that accumulation of fat mass especially visceral fat may have a negative impact on risk of fracture (Piñar-Gutierrez et al, 2022).

Body composition commonly use to describe the percentages of fat, bone and muscle in human bodies. Obese condition led to changes in body composition by increasing body fat percentage (Lopez-


* Correspondence: farahhendara@fk.undip.ac.id

Gomez,2016). Obesity and bone metabolism concept related with body composition. It is very important to assess components of weight that consist of lean mass,fat mass, and water. Lean mass and fat mass are independent determinants of bone mass, and each of them will therefore have a different influence and will depend on several factors.

Dual X-ray absorptiometry (DXA) to measured bone mineral density (BMD), has been the gold standard for the diagnosis of osteoporosis. BMD, a bone quantity parameter, is a major determinant of bone strength and fracture risk.

## 2. Method

This is observational research that was using cross-sectional method that conducted from June-December 2023 at Diponegoro National Hospital (RSND) Semarang. This research approved by Health Research Ethics Committee, Faculty of Medicine, Universitas Diponegoro, Semarang No.195/EC/KEPK/FK-UNDIP/VI.2021.

All respondent in this research were obese women aged 30-50 years who lived in Semarang, Indonesia. Respondent was having normal body temperature (36.5–37.5°C), Body Mass Index >25 kg/m$^2$, and did not have any complication disease such as autoimun, cardiovascular, chronic kidney disease, diabetes mellitus, etc. Respondent in this study also is not currently pregnant or breastfeeding and willing to take part in the study.

### *2.1. Body Mass Index and Body Composition*

Body mass index and body composition was analyzed using TANITA Body Analyzer. TANITA will calculated body mass index, body composition such as lean mass (kg), fat mass (kg), and rating of visceral fat of respondent.

### *2.2. Bone Mineral Density*

Bone mineral density respondent was analyzed using Dual X-ray absorptiometry (DXA) in Semarang Medical Center. Data from DXA was expressed with Z-Score.

## 3. Results

Total respondent in this research was 100 obese women 30-49 years old with mean age 37.51 ± 5.78 years old with almost half of total respondent was 30-35 years (Table1). Mean Body Mass Index (BMI) respondent in this study was 33.08 ± 5.42 kg/m$^2$ with mean waist circumference 97.18 ± 11.17 cm and mean waist height ratio was 0.63 ± 0.07 cm. All respondents in this study were in good health as seen from normal blood pressure, heart rate, respiratory rate, and hemoglobin level (Table 1). Correlation test between body composition and bone mineral density showing that no significant correlation between lean mass and total fat mass with bone mineral density but, viseral fat rating and bone mineral density having significant correlation with p=0,021 with weak correlation strength r=0,230 (Table 2.).

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**Table 1.**
Characteristic respondent.

| No | Variable | Frequency | Mean ± SD |
|---|---|---|---|
| 1 | **Age group:** | | |
| | 30-35 years | 41 (41 %) | |
| | 36-40 years | 27 (27 %) | 37.51 ± 5.78 |
| | 41-45 years | 25 (25 %) | |
| | > 45 years | 7 (7 %) | |
| 2 | Body mass index | | |
| | Obese 1 | 32 (32%) | 33.08 ± 5.42 |
| | < 30 kg/m² | | |
| | Obese 2 | 68 (68%) | |
| | ≥ 30 kg/m² | | |
| 3 | Waist circumference (cm) | | 97.18 ± 11.17 |
| 4 | Waist height ratio | | 0.63 ± 0.07 |
| 5 | Sistole (mmHg) | | 121.88 ± 6.07 |
| 6 | Diastole (mmHg) | | 75.5 ± 5.97 |
| 7 | Heart rate (x-minutes) | | 81.32 ± 4.36 |
| 8 | Respiratory rate (x-minutes) | | 17.27 ± 1.25 |
| 9 | Hb (g/dL) | | 13.21 ± 1.03 |
| 10 | Lean mass (kg) | | 38.74 ± 3.54 |
| 11 | Fat mass (kg) | | 37.79 ± 11.70 |
| 12 | Viceral fat rating | | 10.9 ± 3.96 |

**Table 2.**
Correlation test variable.

| | Bone mineral density | |
|---|---|---|
| | p | r |
| Lean mass | 0.105 | 0.163 |
| Fat mass | 0.062 | 0.188 |
| Viceral fat rating | 0.021* | 0,230 |

**Source:** *Significant.

## 4. Discussion

Anthropometric analysis from respondent in this study describe that all respondent were in obese II condition with mean body mass index 33.08 ± 5.42 kg/m². Obesity divided into two types that was central obesity and perifer obesity (Singh et al, 2022). Respondent in this study included in the central obesity group based on their waist circumferance and waist height ratio (WHtR). Central obesity characterized with fat accumulation occurs in the abdominal area. Waist circumferance and Waist height ratio (WHtR) were anthropometric measurements that usually using as parameter to devine central obesity beside body mass index. World Health Organization (WHO) recommendation describe that waist circumferance above 80 cm for asian women shows signs of central obesity.Waist height ratio was another parameter antropometric for central obesity with the boundary value was 0,5. WHtR above 0,5 categorized as central obesity (Louie, 2023). In this study, mean waist circumference respondent was 97.18 ± 11.17 cm and mean waist height ratio was 0.63 ± 0.07 cm that can be conclude that all respondent was chategorized as central obesity.

Human body consist of water, fat, lean, and bone. Change in body composition especially fat mass in obese condition will affect bone metobilsm. Result for correlation test in this study show that there was positive correlation between lean mass and bone mineral density but the correlation was not significant (p=0,105). Positive correlation between lean mass and bone mineral density in accordance with previous study. Cross-sectional study conducted on premenopausal women in 2016 in South Korea showed that the group of women with BMD Z-score ≥−2.0 had a higher mean muscle mass compared to the group

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with BMD Z-Score <-2SD (Kim et al, 2018). Research in China in 2020 also showed that total muscle mass was significantly correlated with total lumbar BMD (p=<0.001; r=0.279) in respondents of reproductive age for both women and men (Zhang et al, 2022). Other research on Hungarian women also showed that that the group with normal bone mineral density had significant muscle mass compared to the group of women with low bone mass (Vári et al, 2023). Positive correlation between muscle mass and BMD in pre-menopausal women is caused by the adaptive response of osteoblasts to increased mechanical load in individuals who have greater muscle mass (Qin et al,2022). Correlation that was not significant in this study between lean mass and bone mineral density possibly caused by smaller sample size compare to previous study.

Spearman test between fat mass and bone mineral density in this study described that there was also not significant positive correlation between variable (p=0,062). This result is accordance with some previous study. Previous study describes that there was positive correlation between fat mass and bone mineral density (Hilton et al, 2021). Another study that took place in South Korea also show that was positive correlation between fat mass and bone mineral density (Yoon et al, 2023). In pre-menopausal respondent, estrogen is the main reason for this positive correlation mechanism between fat mass and bone mineral density. Estrogen is an inhibitor for osteocalast activity for bone resorption. An increase in adipose tissue in post-menopausal women causes suppression of osteoclasts activities, thus it increases bone mineral density (Hosseini et al, 2021).

Significant correlation in this study was found between visceral fat rating and bone mineral density (BMD). Result from this study describe that there was positive correlation between two variables with weak correlation strength. This result contradicts many previous studies which stated that visceral fat can have a negative effect on bone mineral density. Among this contradiction, there was one research that has similar result with our study. Mechanism behind positive correlation between two variables still unclear. A moderate accumulation of visceral fat may be beneficial for bone health, while excessive visceral fat could potentially have detrimental effects (Sun et al,2023).

We suggest conducting further research on the correlation between body composition and bone mineral density with a larger number of respondents and taking into account other confounding variables.

## 5. Conclusion

Positive correlation was found among body composition that consist of fat mass, lean mass, and visceral fat rating with bone mineral density but, significant correlation only found in visceral fat fat rating and bone mineral density (p=0,021).

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