

# Relationship Between Body Mass Index and Bone Mass Density as a Risk Factor for Osteoporosis in Women

Wijaya, Berri Kusuma

Faculty of Medicine, Islamic University of North Sumatra, Medan, Indonesia

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**Abstract-** Osteoporosis is an abnormal condition characterized by low bone density with the risk of microfractures, especially hip fractures. Risk factors for osteoporosis include the Low Body Mass Index (BMI). This study aims to demonstrate the relationship between body mass index and bone mineral density (BMD) in 347 adult women who underwent ultrasonic bone mineral density measurement (QUS) in Palembang in 2021. The study was conducted using an observational analysis study design with a cross-sectional approach. The majority of the samples were in the normal BMI (37.2%) group, with osteoporotic BMD (48.7%). The results showed that the obese group had a higher BMD score for osteoporosis than the other groups, but there was no statistically significant relationship between BMI and BMD ( $p = 0.132$ ).

**Index Terms-** Bone Mass Density, Body Mass Index, Osteoporosis

## I. INTRODUCTION

Osteoporosis is a disorder characterized by a decrease in bone mass density and disruption of normal bone architecture that affects bone strength, resulting in an increased risk of fracture. Osteoporosis is generally asymptomatic but occurs progressively over years. In advanced stages, osteoporosis results in bone fractures (pathological fractures), a hunched back (kyphosis), loss of height, or back pain. Reduced bone density or bone mass density (BMD) will result in damage to the spinal structure and bone deformities that cause chronic back pain (1). The World Health Organization (WHO) reported that in 1990 the incidence of fractures due to osteoporosis in the world was at 1.7 million people and is predicted to continue to increase so that it is estimated that in 2050 it will reach 6.3 million, with 71% of which will occur in developing countries. growing (2,3). It is noted that there are approximately 200 million patients worldwide suffering from osteoporosis, which is second only to cardiovascular disease. As much as 50% of the incidence of bone fractures due to osteoporosis in the world occurs in Asia, and Indonesia is the country with the second largest prevalence of osteoporosis after China. Compared to people in African countries, the bone density of Europeans and Asians is lower so they have a higher risk of osteoporosis (4). Although osteoporosis can affect both men and women, data from the Indonesian Ministry of Health (2015) show

that the incidence of osteoporosis is more striking in women associated with a progressive decline in the function of the estrogen hormone (5). The International Osteoporosis Foundation (IOF) reports that 1 in 4 women aged 50-80 years have a four times higher risk of developing osteoporosis than men (4). The decline in ovarian function and poor lifestyle results in the prevalence of osteoporosis in women reaching 36%, while men are 27% (5). The process of decreasing BMD in absolute bone mass is dependent on bone mass, and lasts during young adulthood, then rapidly in postmenopausal women and continues progressively in postmenopausal women or men 50 years of age or older (6-8).

Besides the risk factors for age and gender, obesity is also associated with osteoporosis. Currently, there is still controversy about the relationship between obesity as measured by body mass index (BMI) and BMD. Thin people with BMI <18.5 have seven times the risk of osteoporosis compared to normal or obese people (BMI > 18.5). This condition is possible because low BMI is associated with low peak bone mass gain and high bone loss (9). This is similar to the study of Fawzy et al., which stated that low body mass index was a risk factor for osteoporosis (10). Putra's study reported that women aged 30-40 years did not find a significant relationship between BMI and BMD, according to Robbins et al., stating that for BMD, BMI is not a good predictor (9). This gap encourages researchers to find out whether there is a significant relationship between body mass index and the results of BMD examination as an osteoporosis screening method, in addition to the limited studies in Palembang City regarding risk factors for osteoporosis.

## METHODS

This study used a cross sectional method to examine the relationship between body mass index (BMI) and bone mass density (BMD). The sample in this study was taken by consecutive sampling on the target population, namely female patients in the city of Palembang who went to Ar-Rashid Islamic General Hospital, Palembang city for the period February to July 2021. The determination of the minimum number of samples in this study used the proportion estimation formula a population with  $p=0.5$  and  $d=0.1$  so that a minimum sample size of 96 is obtained with an estimated bias of 10%, a minimum sample size of 106 patients is required. In the implementation of the study, 347 patients were willing to participate as research subjects.

Data collection was carried out through interviews (respondent characteristics) and direct measurements. BMI index values were obtained from measurements of height and weight and were grouped according to WHO standards according to the Asia Pacific group. There are various ways of examining bone density, namely bone radiology with single photon absorption (SPA), dual photon absorption (DPA), quantitative computer tomography (CT SCAN) DPA with double X-ray energy (DEXA). The examination using ultrasound is used as an initial screening effort, while DEXA is recommended by WHO as the gold standard for examination of bone density (10,11). The BMD value was obtained by examining the heel (calcaneus bone) using ultrasound bone densitometry (Quantitative Ultrasound Bone Densitometry) with grouping based on WHO criteria. BMD measurement is done by measuring T-score and Z-score. The T-score is the number of deviation scores between the patient's bone density and the average bone density in a population of normal people of the same sex, while the Z-score is a measure of the standard deviation of the expected bone density values in patients for the same age and sex. Descriptively, categorical data is presented with number/frequency and proportion, while numerical data is presented with mean, median, standard deviation and range. Relationship analysis was carried out by using the different proportion test (Chi-Square) with a significance value of  $p < 0.05$ .

**RESULTS**

The data (Table 1) shows that most of the samples were less than 40 years old (42.9%) with BMI in the normal range (37.2%) and features of osteopenia (42.1%), and osteoporosis (48.7%).

**Table 1. Characteristics of research subjects**

Characteristics	N=347
<b>Age</b>	
<40 years	149(42.9%)
40-49 years	61(17.6%)
50-59 years	79(22.8%)
60-69 years	51(14.7%)
>70 years	7(2, 0%)
<b>BMI</b>	
Underweight (<18.5)	24(6.9%)
Normal Range (18.5-22.9)	129(37.2%)
(>=23.0)	0(0.0%)
Risk(23.0-24.9)	67(19.3%)
Obesity(<25.0)	127(36.6%)
<b>BMD</b>	
Normal (0- (+/-1.5)	32(9.2%)
Osteopenia (+/1 ,5)- (+/-2.5)	146(42.1%)
Osteoporosis >(+/- 2.5)	169(48.7%)

*Relationship of Osteoporosis Risk Factors Body Mass Index and Bone Mass Density Examination* In Table 2 it is interesting that the obese group (BMI > 25) had a greater proportion of osteopenia and osteoporosis as well as in the underweight group (< 18.5). The highest proportion of patients with osteoporosis was found to be underweight or obese. However, the results of the *chi square* showed no relationship between the grouping of BMI and BMD.

**Table 2. Comparison of the proportion or relationship between BMI and BMD**

BMI	BMD			P Value
	Normal N=32	Osteopenia N=146	Osteoporosis N=169	
Underweight (<18.5)	4(12.5%)	5(3.4%)	15(8.9%)	0.132
Normal Range (18.5-22.9)	10(31.3%)	51(34.9%)	68(40.2%)	
Overweight (>=23.0)	0(0,0%)	0(0,0%)	0(0,0%)	
At risk (23.0-24.9)	5(15.6%)	36(24.7%)	26(15.4%)	
Obesity (>25.0)	13(40.6%)	54(37.0%)	60(35.5%)	

**DISCUSSION**

*Characteristics of the Sample*

Age is a risk factor for osteoporosis. With increasing age, there will be an increase in *bone loss*, especially in the elderly. In this study, most of the sample groups were women aged less than 40 years, where the highest body mass index (BMI) values were in the normal range group, namely BMI 18.5-22.9 and obesity (BMI>25). There are interesting findings, namely respondents aged less than 40 years with BMI in the normal range but most have BMD values in the osteoporosis group. This can be explained because the increase in cases of osteopenia occurs at a young age. The Indonesian Ministry of Health through its study reports that the incidence of osteopenia is mostly found in young people aged less than 25 years with a prevalence of 37.1% (12). Osteoporosis

is preceded by osteopenia, which is a condition with low bone density, which lasts for a long time, resulting in a decrease in bone strength (12).

Women have a six times greater risk than men of osteoporosis because they have less bone mass and lose bone mass more quickly. The theory suggests that at the age of over 40 years will begin to decline in bone mass and will continue until death. Many theories state that after menopause, due to the absence of the hormone estrogen, women lose their protective effect, so that the course of bone remodeling is disrupted and eventually osteoporosis occurs (13). In the elderly, in addition to a decrease in bone mass, there are also changes in muscle function and structure. Muscle mass will decrease with age. This is an important predictive factor of functional limitations and physical disability

in the elderly and certainly increases the risk of fracture complications (14).

The prevalence of osteoporosis is also influenced by inappropriate behavior and lifestyle, including nutritional knowledge, sports activities and having control over their health. One of the important factors is the recommended calcium intake of 500 mg/day for women aged 29-49 years. Research has shown that low calcium intake will have an effect on decreasing bone density. Setyawati reported that the results of statistical analysis showed that low calcium consumption was twice as likely to experience lower bone density than samples with sufficient calcium intake (15). There is a tendency in East Asia and Southeast Asia, including in Indonesia to find low levels of calcium intake with a low pattern of milk intake, especially in women (9,15). In addition to calcium intake, what is also important is the consumption of phosphorus, and vitamin D as well as protein intake. Protein plays an important role in achieving peak bone mass, so that individuals with low protein intake are at risk of having low BMD, thereby increasing the risk of loss of bone mass density (16). In addition to nutritional factors, physical activity also plays a role because it causes mechanical movements that strengthen bone strength so that it can determine body health. Bone mass density is influenced by physical activity and sports that are loading, muscle pressure/stretching and gravity (9,17,18). *Relationship between Osteoporosis Risk Factors Body Mass Index and Bone Mass Density Examination* Body mass index can describe a person's nutritional status. A large body mass index causes an increase in the mechanical load of bone, the production of estrogen by adipose tissue, thereby reducing the rate of disassembly of bone mass (19,20). Eka's research in Bandung concluded that there was no relationship between BMI, body fat mass, and waist circumference with bone density in early adult women (21). Moayyeri reported that the percentage of body fat is a predictor of fracture risk due to osteoporosis in women (19).

In this study, there was no significant relationship between BMI and BMD. The same thing was also found in the research of Setyawati, Mutia, and the Indonesian Ministry of Health in 2007 that there was no significant relationship between BMI and BMD (12,15). However, several other studies found a significant relationship between BMI and BMD, as Farida did in Pontianak (22). Setyawati's research shows that someone with a thin body posture (BMI < 18.5) has a 7 times risk of osteoporosis compared to those who have a normal body posture (BMI > 18.5 (10). Muscle mass has an important role in BMD, especially in premenopausal women compared to those with a normal body posture. in postmenopausal women. However, genetic conditions and race also influence bone mass density, fat mass and muscle mass. Kim found a positive correlation between body weight, BMI and BMD in women's lumbar spine with the correlation coefficient between body weight and BMD higher than between BMI and BMD, which means low weight is much more likely to be associated with osteoporosis without other factors being considered (23).

The non-significant relationship between BMI and BMD in this study could be because the sample studied had a BMI in the normal BMI range, so the data tended to be almost the same and the range is not too wide. Besides that, BMI alone cannot describe the situation with certainty in the order of the sample because it cannot distinguish whether the body composition of the sample is

dominated by fat or muscle mass. Differences in results can also be caused by differences in measuring instruments, in this study using the QUS method is different from Fawzy who uses the DEXA measuring instrument. Fawzy found low BMD was recorded in 59.1% of women and 76.9% of men. The association between advanced age and lower BMI is an important risk factor for low TDM (10).

The results of this study concluded that in the sample of women in Palembang City, obese individuals according to BMI tend to have a large proportion of osteoporosis, although statistically no statistically significant relationship was found between body mass index and bone mass density.

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#### AUTHORS

**First Author** – Wijaya, Berri Kusuma, Faculty of Medicine, Islamic University of North Sumatra, Medan, Indonesia