Food Research 4 (Suppl. 3) : 54 - 62
Journal homepage: http://www.myfoodresearch.com

FOOD RESEARCH

FULL PAPER

Relationship between body type (somatotype) and bone density in perimenopause women

[1]Saphira, R.R., [1,2]Widyastuti, N. and [1,2,]*Fitranti, D.Y.

[1]*Department of Nutrition Science, Faculty of Medicine, Universitas Diponegoro, Jln. Prof Soedarto SH, Tembalang, Semarang, 50275*
[2]*Center of Nutrition Research (CENURE) Jln. Prof Soedarto SH, Tembalang, Semarang,50275*

Article history:
Received: 29 December 2019
Received in revised form: 14 February 2020
Accepted: 16 February 2020
Available Online: 30 May 2020

Keywords:
Somatotype,
Bone density,
Adult women

DOI:
https://doi.org/10.26656/fr.2017.4(S3).S14

Abstract

Along with increasing age in women, there will be a decrease of estrogen levels and changes in the size, structure, and composition of the body, so those will affect bone density. This study aimed to analyze the relationship between body type (somatotype) and bone density in perimenopause women. This study was a cross-sectional study held in Ngemplak, Simongan, West Semarang with forty-two women subjects aged 31-50 years. Their bone density was estimated using QUS on calcaneal. Somatotype was measured using skinfold caliper, medline and sliding caliper. Bivariate analysis used Pearson Correlation and Rank-Spearman correlation test. Multivariate analysis used multiple regression test. All body types were grouped as endomorph, mesomorph, and ectomorph. Most subjects have mesomorph type were 71.4% (n = 30). Subjects with osteopenia were 4.8% (n = 2). There was a positive correlation between endomorph values, mesomorph values and body fat percentage with bone density scores in bivariate analysis. There was correlation between mesomorph values, body fat percentage and body mass index with bone density scores in subjects (SC = 0.533; p = 0.037, SC = 0.590; p = 0.011, SC = -0.643; p = 0.037) in multivariate analysis. In conclusion, there were significant correlations between mesomorph values with bone density scores.

1. Introduction

The adult period is the period when a person reaches physical maturity, usually occurring from the age of 20 years. Women age 30 years and over, physiologically will experience a decrease in estrogen levels called perimenopause. Decreasing estrogen levels during perimenopause can increase the risk of bone fragility, resulting in a high potential for fractures (McGuire and Beerman, 2013). Osteoporosis is a disease characterized by a decrease in bone mass due to the inability of the body to regulate mineral content in the bone, resulting in decreased bone strength. Fractures caused by osteoporosis can lead to death (Dieny and Fitranti, 2017). The prevalence of osteoporosis and fractures caused by osteoporosis keep increasing from years to years and become one of the main health problems in Asian countries (Mithal and Kaur, 2012; Kementrian Kesehatan RI, 2015). Based on a study by Tirtarahardja *et al*. (2006), the prevalence of osteoporosis in Indonesian women (aged 50-80 years) was 22.5% and 32% on aged 60-80 years. In 2007, the Osteoporosis Association in Indonesia showed that there was an increase in the prevalence of osteoporosis, especially in women over 50 years by 32% (Kementrian Kesehatan RI, 2015). In addition, data from the Health Profile in Semarang showed that prevalence of osteoporosis increased from 2016 to 2017 was 1.03% (Badan Pusat Statistik Kota Semarang, 2018).

Risk factors that can cause osteoporosis are divided into two namely changeable and unchangeable risk factors. Risk factors that can be changed are nutrient intake, especially vitamin D and calcium intake, alcohol consumption, smoking, use of glucocorticoid drugs and physical activity. Meanwhile, unchangeable risk factors are age, sex and genetic factor related to bone density (Vijayakumar and Busselberg, 2016). Low body mass index (BMI) is often found in studies as a risk factor of osteoporosis (Sözen *et al.*, 2017). However, high body mass index (BMI) in some studies is positively correlated with bone density. Obese women based on BMI are found to have protective factors against bone density. However, obesity as a protective factor for bone mass is still debated. Changes in the body both in terms of size, structure, proportion and body composition can

*Corresponding author.
Email: *denyyudi@gmail.com*

eISSN: 2550-2166 /

affect body type (Mazocco and Chagas, 2016). Human body types have been described as endomorph, mesomorph, and ectomorph commonly called somatotype (Carter, 2002).

Somatotype is a quantitative description of a person's physique type introduced by Heath and Carter which consisted of three components: endomorph, mesomorph, and ectomorph (Galic *et al*., 2016). Endomorph has a fat body build; mesomorph has strong bones and ectomorph has a very thin build. Endomorph is characterized by a round body, big and round head, short bones, short neck, narrow shoulders, wide legs, and waist. Mesomorph type is characterized by a solid body, hard, muscular, large bones, relatively have a small waist, and broad shoulders, usually this type is found in athletes. The ectomorph type is characterized by a thin or slender body, small bones, uniform lumbar abdomen and arches, narrow shoulders and invisible muscles. In this type of muscle mass and fat is lower than the other two types (Saitoglu *et al*., 2007; Galić *et al*., 2016).

Research related to the relationship between somatotype and bone density is still limited. Previous studies have shown a correlation between somatotype and bone density in mid-adult male subjects that the endomorph and mesomorph types are positively and significantly correlated with high levels of bone density, from measurements of the proximal hip bone and femur density using DXA. Subjects with endomorph and mesomorph type are related to bone density (Saitoglu *et al*., 2007). However, it is not explained how somatotype relates directly to bone density. However, it is explained indirectly through the existence of a significant relationship between body mass index with the somatotype component. Body mass index with normal, overweight, and obese categories was found to be more dominant than the underweight category. Therefore, the dominant types of somatotype found in this study are mesomorph and endomorph. The results of this study stated that the higher BMI, the better bone density. However, the weakness of BMI cannot describe body composition (fat mass and muscle mass) (Galić *et al*., 2016). Research about association between somatotype and bone density has never been done in Indonesia. Based on this background, the researchers wanted to conduct research on the relationship between body shape (somatotype) and bone density in adult women aged 31-50 years.

2. Materials and methods

This study was an observational study with a cross-sectional study design in which each variable was measured once at a time. This study was conducted in Ngemplak Region, Simongan, West Semarang. The variables were components of body type (endomorph, mesomorph, and ectomorph), bone density, age, physical activity, nutrient intake (carbohydrate, fat, protein, caffeine, vitamin D, calcium intake), BMI and body fat percentage. Criteria for inclusion of the sample included women aged 31-50 years, not menopause yet, not pregnant or breastfeeding, not suffering from chronic diseases, not taking drugs such as glucocorticoids, steroids, and hormone drugs, not smoking, not consuming alcohol and willing to be the subject of research by filling out the Informed Consent. Exclusion criteria in this study included not being present during data collection, resigning before the study was completed, and passing away. The selection of research subjects was done by purposive sampling method.

Screening was done through the interview to the subjects, adjusting the inclusion criteria. Ninety-three subjects from screening process, obtained 50 person who met the inclusion criteria. Fifty subjects become 42 people due there were subjects who were absent during data collection and were excluded during data processing. The significance of the study (Zα) was 95%, while the research power (Zβ) was 80%, and the correlation coefficient (r) was 0.48 (Saitoglu *et al*., 2007). The result of calculating the sample size by considering the drop out was 37 subjects. Data of anthropometric measurements were body weight, height, skinfolds (triceps, calf, subscapular and supraspinal), bone width measurement (humerus and femur), girth (bicep girth and calf girth). In addition, bone density data, food intake and physical activity. This study was approved by The Ethical Committee of Medical Research of Faculty of Medicine, Universitas Diponegoro (No.143/EC/KEPK/FK/UNDIP/V/2019).

Anthropometry data of body type was done by direct measurements, such as body weight, height, skinfolds (triceps, calf, subscapular and supraspinal), width (humerus and femur), and girth (bicep girth and calf girth). Body weight was measured using digital weight scale (OMRON) with an accuracy of 0.1 kg. Height was measured using microtoise with an accuracy of 0.1 cm. Jamar type skinfold caliper, to measure the body skinfolds with an accuracy of 1 mm. Girth measurement using medline and body width using sliding caliper with an accuracy of 0.02 mm. Measurement of body fat percentage using the Bioimpedance Analysis (BIA) (OMRON). Anthropometry measurements were done twice for each variable.

Measurement of bone density using bone densitometry OsteoSys SONOST 2000 and categorized by T-score. Bone density measurements were carried out by experts from the KALBE Company. We used QUS because it was inexpensive, easy to carry, easily available, and easily accessible as an alternative to measuring Dual-X absorptiometry energy (DXA) measurements of bone mineral density (BMD) to assess fracture risk in many studies (Hans and Baim, 2017). Among the quantitative ultrasound measurements of the heel is considered one of the best alternative methods at present because it is available for assessment of fracture risk. The advantage of this technique is the possibility of detecting structural bone characteristics (elastic properties, trabecular orientation) thus enabling better quantification of bone quality (Quiros-Roldan *et al*., 2017). Normal bone density if it has T-score ≥-1.0 SD and has low bone density if T-score <-1.0 SD. Food intake data was done by interview using the Semi-Quantitative FFQ method and food photographic instruments. Food intake data were analyzed using the Nutrisurvey 2004 program. Physical activity data was measured using the short-form International Physical Activity Query (IPAQ) form.

Body types are categorized into three: endomorph, mesomorph and ectomorph. Endomorph can be categorized if the first number is greater than the other two numbers (mesomorph and ectomorph). Classified as mesomorph if the second number is greater than the other two numbers (endomorph and ectomorph). Ectomorph can be categorized if the third number is greater than the other two numbers (mesomorph and endomorph) (Carter, 2002). Physical activity is divided into three categories: low (<600 MET/minute/week), moderate (600-2999 MET/minute/week) and high (≥3000 MET/minute/week) (IPAQ Guideline). Body mass index is divided into three categories: underweight (<18.5 kg/m^2), normal (18.5 – 22.9 kg/m^2), and overweight (>22.9 kg/m^2) (Anjani and Kartini, 2013; Pi-sunyer *et al*., 2014). Body fat percentage consist of three categories: normal (18-32%), overweight (33-35%), and obesity (>35%) (Pi-sunyer *et al*., 2014). Adequate intake of nutrients, such as carbohydrate, fat, protein, vitamin D and calcium intake are divided into three categories: low (<90% of RDA), normal (90-119% of RDA), and excessive (≥120% of RDA) (Rochmah *et al*., 2017). Caffeine intake is categorized into three: low (<200 mg/day), moderate (200-400 mg/day), and high (>400 mg/day) (Devi *et al*., 2016).

Somatotype was done by anthropometric measurements such as body weight, height, skinfold triceps, calf, subscapular and supraspinal, width (humerus and femur, and girth (biceps girth and calf girth. The results of anthropometric data measurements are then entered into the somatotype formula equation. The endomorph component formula is -0.7182 + 0.1451 (X) – 0.00068 (X^2) + 0.0000014 (X^3) where X is 170,18 x (trisep skinfold + subscapula skinfold + suprailiaca skinfold). The mesomorph component formula is [(0.858 x humerus width) + (0.601 x femur width) + (0.188 x CAG) + (0.161 x CCG) – (height x 0.131) + 4.5. CAG (corrected arm girth) is bicep girth – triceps skinfold/10, meanwhile CCG (corrected calf girth) is calf girth – calf skinfold/10 (Carter, 2002).

Somatotype has three numbers, where the first number is an indication of endomorph, the second number is mesomorph and the third number is ectomorph. The three numbers then categorized into 13 somatotype categories by Heath-Carter, namely central, balanced endomorph, mesomorphic endomorph, mesomorph-endomorph, endomorphic mesomorph, balanced mesomorph, ectomorphic mesomorphic, mesomorph-ectomorph, mesomorphic ectomorph, balanced ectomorph, endomorphic ectomorph, endomorph-ectomorph, ectomorphic endomorph. The 13 categories can be simplified into four categories are *central*, *endomorph*, *mesomorph* dan *ectomorph* (Carter, 2002).

Univariate analysis was performed to describe the characteristics of the subject, the variables studied included independent (somatotype measurement), dependent variable (measurement of bone density) and confounding variables (age, carbohydrate intake, fat intake, caffeine intake, calcium intake, vitamin D intake, BMI, percentage body fat, and physical activity) by entering data in the frequency distribution table. Normality test used Saphiro-Wilk because the number of samples is less than 50. Bivariate analysis was done to analyze the relationship between somatotype and bone density in adult women aged 31-50 years. Moreover, bivariate analysis was also conducted to determine the relationship of each confounding variable with bone density scores. Bivariate analysis was performed using the Spearman Rank test on which data were abnormally distributed and the Pearson Correlation test on normally distributed data. Multivariate analysis using the Multiple Linear Regression test.

3. Results

3.1 Subject characteristics

The means age of the study subjects was 40 years old as seen in Table 1. The minimum value of the subject's bone density score was -1.3, which indicated that there were subjects who had osteopenia. Body type categories can be divided into two, namely based on 13 categories (category 1) and 4 categories (category 2).

The category 1 body type that had the greatest frequency was a balanced mesomorph of twenty

FULL PAPER

Table 1. Subject characteristics

Characteristics	n	%	Min	Max	Mean/Median
Age			31	50	40.2±5.41[a]
31 - 40 years	22	52.4			
41 - 50 years	20	47.6			
Bone Density Score			-1.3	0.9	-0.30±0.54[a]
Normal (≥ -1 SD)	40	95.2			
Osteopenia (< -1 SD)	2	4.8			
Catergory 1 of body type					
Mesomorphic endomorph	3	7.1			
Endomorphic mesomorph	3	7.1			
Balanced mesomorph	20	47.6			
Ectomorphic endomorph	2	2.4			
Mesomorph-ectomorph	7	11.9			
Mesomorphic ectomorph	1	7.1			
Balanced ectomorph	5	11.9			
Endomorphic ectomorph	1	2.4			
Catergory 2 of body type					
Endomorph	6	14.3	0.1	1	0.35[b]
Mesomorph	23	71.4	0.1	9	2[b]
Ectomorph	6	14.3	0.1	5,2	0,1 [b]
Mesomorph-ectomorph	7	11.9			
Nutritional Status			19.6	41,7	27.8±5.24[a]
Normal	8	19			
Overweight	34	81			
Physical Activity			360	3297	1524.7±715.1[a]
Low	4	9.5			
Moderate	37	88.1			
High	1	2.4			
Body Fat Percentage			26.3	43.6	36.5±3.89[a]
Normal	4	9.5			
Overweight	10	23.8			
Obesity	28	66.7			

[a]Mean±SD, [b]Median

subjects. Based on the four categories, the largest number of body types was mesomorph of 71.4% (n = 30). The dominant nutritional status in the subject was fat with a mean of 27.8 kg/m^2. Most of the subjects were categorized as obesity according to body fat percentage.

Table 2 shows that the adequate levels of carbohydrate, protein, fat, calcium, vitamin D and caffeine intake. Most of the subjects were categorized as low intake. Endomorph body type values (r = 0.38; p = 0.013) were related to bone density as in Table 3. The higher the endomorph value, the greater the bone density score. The mesomorph type variable (r = 0.31; p = 0.045) was positively related to bone density. The variable body fat percent (r = 0.26; p = 0.004) was positively related to bone density. The higher the percentage of body fat, the greater the bone density score.

The body mass index, percent body fat, and mesomorph values had a relationship with bone density after being analyzed using linear regression tests as shown in Table 4. The adjusted R square value was 0.241 = 24.1%. The result showed that bone density was simultaneously influenced by BMI, value mesomorph and body fat percent were 24.1% while the rest were influenced by variables not examined.

4. Discussion

Based on the subject characteristics, there were two subjects with osteopenia, while most subjects had normal bone density. The mean age of the subjects was 40 years. This is consistent with the previous study by Dieny and Fitranti (2017) in which subjects in the 40-50 years age range had the lowest frequency in the osteopenia

Table 2. Food intake characteristics

Characteristics	n	%	Min	Max	Mean/Median
Carbohydrate Intake			0.2	1.3	0.48[b]
Low	39	92.9%			
Normal	2	4.8%			
High	1	2.4%			
Protein Intake			0.27	1.41	0.62[b]
Low	34	81%			
Normal	5	11.9%			
High	3	7.1%			
Fat Intake			0.19	1.82	0.67[b]
Low	32	76.2%			
Normal	3	7.1%			
High	7	16.7%			
Calcium Intake			0.08	1.02	0.24[b]
Low	40	95.2%			
Normal	1	2.4%			
High	1	2.4%			
Vitamin D Intake			0	2.6	0.16[b]
Low	39	92.9%			
Normal	1	2.4%			
High	2	4.8%			
Caffeine Intake			0	276.8	66.2[b]
Low	41	97.6%			
Normal	1	2.4%			

Table 3. Relationship among somatotype components, age, BMI, body fat percentage, and physical activity with bone density

Confounding Variables	Bone density scores	
	r	p
Endomorph	0.38[a]	0.013[a]
Mesomorph	0.31[a]	0.045[a]
Ectomorph	-0.16[a]	0.304[a]
Age	0.21[b]	0.187[b]
Body Mass Index (BMI)	0.26[b]	0.091[b]
Body Fat Percentage	0.44[b]	0.004[b]
Physical Activity	-0.23[b]	0.14[b]
Food Intake		
Carbohydrate	0.04[b]	0.785[b]
Protein	-0.04[b]	0.8[b]
Fat	-0.42[a]	0.792[a]
Calcium	-0.15[a]	0.342[a]
Vitamin D	0.29[a]	0.056[a]
Caffeine	0.12[a]	0.453[a]

[a]Rank-Spearman, [b]Pearson

Table 4. Multiple linear regression test

Variables	Bone Density			
	[a] SC	[b] p1	[c] p2	Adjusted R Square
Body Mass Index (BMI)	-0.643	0.037	0.004	0.241
Body Fat Percentage	0.59	0.011		
Mesomorph	0.533	0.037		

[a] Standardized Coefficient, [b] Significance of T-test, [c] Significant of F-test (ANOVA)

category compared to subjects in the 51-60 years, 61-70 years and 71-80 years age groups. In addition, previous study showed that there was no change in the mean bone mass at the age of 35-44 years group (Berger *et al.*, 2008). This study showed that most subjects had mesomorph body types. This is in accordance with a study by Kalichman and Kobyliansky (2006) in which mesomorph body types were more common in subjects with the age group 31-40 years and 41-50 years compared with the age group 18-30 years.18 Based on the results of bivariate analysis test found a correlation between endomorph values, mesomorph and body fat percent with bone density. Variables that have a p value <0.25 followed by the analysis of the relationship test using multiple linear regression test. The results of multiple linear regression tests showed that the variables that correlated with bone density were mesomorph values, body fat percent, and Body Mass Index.

4.1 Relationship between body type (somatotype) with bone density

This study showed a correlation between mesomorph body type score and bone density. The relationship between the two had a positive correlation, indicating that the greater the value of the mesomorph body type components, the better bone density. Mesomorph type is characterized by a solid body, hard, muscular, large bones, relatively have a small waist, and broad shoulders, usually this type is found in athletes.

eISSN: 2550-2166

Mesomorph type is usually dominated by muscle mass. The positive correlation between mesomorph and bone density in this study, in accordance by Patel *et al*. (2018) that lean mass can improve bone size and strength. Muscles and bone are related to each other from the beginning of embryonic development to adulthood, thus affecting bone function and structure. Muscles and bones will get bigger and stronger due to the growth process, physical activity and adequate intake of nutrient that support bone health, especially vitamin D and calcium (Patel *et al*., 2018). Lean mass can improve bone density through the body's mechanical load. Bone strength can be affected by mechanical muscle movements and hormonal factors. Bone strength is affected by the amount of lean mass in body composition. Lean mass in human body can be obtained through physical activity. Most of the subjects had moderate physical activity, thus it is possible to have a large mechanical burden as well. This has resulted in the bone density score in most subjects belonging to the normal category. Muscle strength and physical activity have a more significant impact on bone health compared to hormonal factors, especially in premenopausal women (Ho-Pham *et al*., 2014). Moreover, lean mass has more significant effect on increasing bone density than body fat mass.

4.2 Relationship between body fat percentage with bone density

The result of this study was similar with study by Moayyeri *et al*. (2012) that there is correlation between body fat percentage and bone density in subjects (bone density was measured by Quantitative Ultrasound on calcaneal). Women with body fat percentage <20%, have 3.5 times the risk of bone fracture on the waist and 2.2 times increase bone fracture risk on the other areas compared to women with body fat percentage of about 40%.

Fat mass and lean mass in the body have a role to maintain bone density through the mechanism of mechanical load on the bone. Abdominal fat consists of subcutaneous fat and intraabdominal fat. Intraabdominal fat consists of visceral fat which composes fat mass in small intestine and kidney (Wajchenberg, 2000). There are two types of fat associated with bone, namely visceral fat and subcutaneous fat. Both have different effects on bones. Some studies explained that visceral fat has negative impact on bones through increased proinflammatory cytokines, such as TNF-α and IL-6. Increasing the amount of visceral fat in the body can cause the risk of arteriosclerosis, insulin resistance, and type 2 diabetes mellitus so that it can reduce bone density (Gilsanz *et al*., 2009; Campos *et al*., 2012). Subcutaneous fat has protective effect on bones. However, the mechanism of the protective effect of subcutaneous fat on bone still remain unclear.

Anthropometry measurement that can describe visceral fat is waist-hip ratio, whereas to describe subcutaneous fat can use somatotype. Initially, fat is stored in subcutaneous fat tissue, but if the capacity of subcutaneous fat tissue has been obtained, it will be stored in visceral fat tissue and non-fat tissue such as skeleton muscle. This study showed that mesomorph was the dominant body type. This is consistent with the study by Galić *et al*. (2016) that the mesomorph value is higher than the endomorph and ectomorph values caused by fat deposits in skeletal muscle so that the width of the femur and humerus is greater. In addition to the mesomoporh value reflecting muscle mass, the mesomorph value also consists of several measurements of peripheral or subcutaneous fat stored under the skin. Women tend to have total fat deposits in the gluteal or femoral area (thigh area) and subcutaneous area of the skin. Body weight and abdominal fat distribution differ in women of childbearing age and women who have gone through menopause. Decreased estrogen levels in menopausal women are followed by a decrease in subcutaneous fat and an increase in abdominal or visceral fat (Lizcano and Guzmán, 2014). Women that included in this research were a perimenopause woman, it was assumed that subcutaneous fat in the body was still in large amounts and had a positive impact on bone density.

4.3 Relationship between BMI, physical activity, age with bone density

In this study, BMI was negatively correlated with bone density. This means that the greater BMI will reduce the bone density. In addition, this is consistent with research according to Silva *et al.* (2015) that overweight and obese women tend to have low bone density (osteopenia and osteoporosis). The majority of research states that a greater body mass index will increase bone density through the body's mechanical load mechanism. However, Compston *et al.* (2011) said that obesity does not have a protective factor in postmenopausal women who experience fractures, although they have high BMI value. Some studies said that obesity can increase bone density through hormonal mechanisms and mechanical loads. However, abdominal obesity can lead to some diseases such as insulin resistance, diabetes mellitus, metabolic syndrome so that it can disrupt bone metabolism through inflammation (Gürlek *et al*., 2018). Our research showed that two subjects who had overweight BMI were included in osteopenia category. This means that BMI is negatively correlated with bone density.

Physical activity has a role as a mechanical load to stimulate bone formation so that it affects bone size, shape and strength. The majority of research shows that physical activity is positively correlated with bone density (Alghadir *et al*., 2015). However, there is no relationship between physical activity and bone density in this study. Some studies state that physical activity and bone density were not related because of the intensity and frequency of low physical activity (Tan *et al*., 2014). Based on interviews on subjects regarding their physical activity, the results obtained that most subjects have a moderate physical activity. However, they did not do a specific physical activity that can improve bone density significantly such as washing, sweeping, drying and so forth. Most of the subjects are textile factory workers that most of the time they work is sitting. The type of physical activity mentioned in several studies that has a significant impact on bone density is regular exercise. The American College of Sports Medicine (ACSM) states that to improve bone density, a person must have an active lifestyle such as aerobic exercise and moderate to high-intensity sports such as jumping, squats, weightlifting and so on (Arazi and Eghbali, 2017; Benedetti *et al*., 2018).

One factor that affects bone density is age. Women will experience a decrease in bone mass greater than men when entering into menopause phase due to a decrease in the hormone estrogen. Estrogen plays a role in vitamin D regulation where vitamin D will help reabsorption of calcium in the kidneys and affect the process of bone formation (Aminah *et al*., 2009). Study explained that low bone density occurs with increasing age (Ho-Pham *et al*., 2014; Mishra *et al*., 2016). Along with increasing age, the bone will become thin and more porous about 4-10% since the age of 40 years. After the age of 40 years, bone-thinning will decrease to 3% per decade and increase up to 9% per decade in menopause women (Aminah *et al*., 2009). There was no association between age and bone density in our study both in 31-40 years and 41-50 years groups. This was because the mean age in this study was 40 years and in perimenopause period where it is possible that estrogen levels have not to decrease yet, thus the bone density in subjects is still in good condition.

The limitation of our study is that we used QUS to measure bone mass density, where QUS is not a gold standard tool. The limitation of QUS is a less accurate tool to predict bone mass density because it only measures calcaneal compared to DXA which predicts bone density through several bones located in the human body (lumbar spine, femoral neck).

4. Conclusion

Increased mesomorph component and body fat percentage values can increase bone density. However, high BMI in this study can decrease bone density in perimenopause women. Further research should examine the body type and bones mass density in adult women with inflammatory biomarkers corrections such as cytokines interleukin-6 (IL-6), tumor necrosis factor-α (TNF-α) and inflammatory marker of C-reactive protein (CRP).

Conflict of Interest

The authors declare no conflict of interest.

Acknowledgments

With sincere appreciation, the authors gratefully acknowledge official workers in the Health Service (Puskesmas) and our subjects.

References

Alghadir, A.H., Gabr, S.A. and Eisa, E.A. (2015). Physical activity and lifestyle effects on bone mineral density among young adults: sociodemographic and biochemical analysis. *Journal of Physical Therapy Science*, 27(7), 2261–2270. https://doi.org/10.1589/jpts.27.2261

Aminah, H.S., Mahmud, M. and Rahajoeningsih, P. (2009). Relationship between the age, the bone density and the height of mandibular residual ridge in edentulous menopausal women. *Padjajaran Journal of Dentistry*, 21(1), 25–31. https://doi.org/10.24198/pjd.vol21no1.14081

Anjani, R.P. and Kartini, A. (2013). Perbedaan pengetahuan gizi, sikap dan asupan zat gizi pada dewasa awal (mahasiswa LPP graha wisata dan sastra inggris Universitas Diponegoro Semarang). *Journal of Nutrition College*, 2(3), 312–320. [In Bahasa Indonesia].

Arazi, H. and Eghbali, E. (2017). Effects of different types of physical training on bone mineral density in men and women. *Journal of Osteoporosis and Physical Activity*, 5(3), 1–5. https://doi.org/10.4172/2329-9509.1000207

Badan Pusat Statistik Kota Semarang. (2018). Profil Kesehatan Kota Semarang 2017, p. 62-63. Retrieved from https://semarangkota.bps.go.id/publication/download.html?nrbvfeve=YzhlNGE5Zjk4MWUzOWZmZjE2NDcwYWRi&xzmn=aHR0cHM6Ly9zZW1hcmFuZ2tvdGEuYnBzLmdvLmlkL3B1YmxpY2F0aW9uLzIwMTgvMTIvMTgvYzhlNGE5Zjk4MWUzOWZmZjE2N

DcwYWRiL3Byb2ZpbC1rZXNlaGF0YW4ta290YS1zZW1hcmFuZy0yMDE3Lmh0bWw%3D&twoadfnoarfeauf=MjAyMC0wNC0wNyAwOTo1NjowMw%3D%3D [In Bahasa Indonesia].

Benedetti, M.G., Furlini, G., Zati, A. and Mauro, G.L. (2018). The effectiveness of physical exercise on bone density in osteoporotic patients. *BioMed Research International*, 2018, 4840531. https://doi.org/10.1155/2018/4840531

Berger, C., Langsetmo, L., Joseph, L., Hanley, D.A., Davison, K.S., Josse, R., Kreiger, N., Tenenhouse, A., Goltzman, D. and the Canadian Multicenter Osteoporosis Study Research Group (2008). Change in bone mineral density as function of age in women and men and association with use of antiresorptive agents. *Canadian Medical Association Journal*, 178 (13), 1660-1668. https://doi.org/10.1503/cmaj.071416

Campos, R.M.S., Lazaretti-Castro, M., de Mello, M.T., Tock, L., Silva, P.L., Corgosinho, F.C., Carnier, J., de Piano, A., Sanches, P.L., Masquio, D.C.L., Tufik. S. and Dâmaso, A.R. (2012). Influence of visceral and subcutaneous fat in bone mineral density of obese adolescents. *Arquivos Brasileiros de Endocrinologia and Metabologia*, 56(1), 12-18. https://doi.org/10.1590/S0004-27302012000100003

Carter, J.E.L. (2002). The Heath-Carter Anthropometric Somatotype. Instruction Manual. Retrieved from website: http://www.somatotype.org/Heath-CarterManual.pdf

Compston, J.E., Watts, N.B., Chapurlat, R., Cooper, C., Boonen, S., Greenspan, S., Pfeilschifter, J., Silverman, S., Diez-Perez, A., Lindsay, R., Saag, K.G., Netelenbos, J.C., Gehlbach, S., Hooven, F.H., Flahhive, J., Adachi, J.D., Rossini, M., LaCroix, A.Z., Roux, C., Sambrook, P.N. and Siris, E.S. (2011). Obesity is not protective against fracture in postmenopausal women: GLOW. *The American Journal of Medicine*, 124(11), 1043-1050. https://doi.org/10.1016/j.amjmed.2011.06.013

Devi, A. V. S., Soviana. E. and Zulaekah, S. (2016). Hubungan asupan kafein dengan tekanan darah pada pekerja bagian produksi PT Tiga Serangkai Surakarta. Surakarta: Universitas Muhammadiyah Surakarta. Diploma Thesis.

Dieny, F.F. and Fitranti, D.Y. (2017). Faktor risiko osteoporosis pada wanita usia 40-80 tahun: status menopause dan obesitas. *Jurnal Gizi Klinik Indonesia*, 14(2), 45–55. [In Bahasa Indonesia]. https://doi.org/10.22146/ijcn.24872

Galić, B.S., Pavlica, T., Udicki, M., Stokić, E., Mikalački, M., Korovljev, D., Čokorilo, N., Drvendžija, Z. and Adamović, D. (2016). Somatotype characteristics of normal-weight and obese women among different metabolic subtypes. *Archives of Endocrinology and Metabolism*, 60(1), 60-65. https://doi.org/10.1590/2359-3997000000159

Gilsanz, V., Chalfant, J., Mo, A.O., Lee, D.C., Dorey, F.J. and Mittelman, S.D. (2009). Reciprocal relations of subcutaneous and visceral fat to bone structure and strength. *Journal of Clinical Endocrinology and Metabolism*, 94(9), 3387–3393. https://doi.org/10.1210/jc.2008-2422

Gürlek, Y.S., Kalaycıoğlu, A. and Gürlek, B. (2018). The effect of body mass index on bone mineral density in postmenopausal women. *International Journal of Research in Medical Sciences*, 6(11), 3482–3487. https://doi.org/10.18203/2320-6012.ijrms20184403

Hans, D. and Baim, S. (2017). Quantitative Ultrasound (QUS) in the Management of Osteoporosis and Assessment of Fracture Risk. *Journal of Clinical Densitometry*, 20(3), 322-333. https://doi.org/10.1016/j.jocd.2017.06.018

Ho-Pham, L.T., Nguyen, U.D.T. and Nguyen, T.V. (2014). Association between lean mass, fat mass, and bone mineral density: a meta-analysis. *The Journal of Clinical Endocrinology and Metabolism*, 99(1), 30–38. https://doi.org/10.1210/jc.2013-3190

Kalichman, L. and Kobyliansky, E. (2006). Sex- and age-related variations of the somatotype in a Chuvasha Population. *Journal of Comparative Human Biology*, 57(2), 151–162. https://doi.org/10.1016/j.jchb.2006.01.002

Kementrian Kesehatan RI. (2015). Pusat Data dan Informasi Kementerian Kesehatan RI. Retrieved from Kementeriaan Kesehatan RI webstie: https://pusdatin.kemkes.go.id/. [In Bahasa Indonesia].

Lizcano, F. and Guzmán, G. (2014). Estrogen Deficiency and the Origin of Obesity during Menopause. *BioMed Research International*, 2014, 757461. https://doi.org/10.1155/2014/757461

Mazocco, L. and Chagas, P. (2016). Association between body mass index and osteoporosis in women from Northwestern Rio Grande do Sul. *Revista Brasileira de Reumatologia (English Edition)*, 57(4), 299–305. https://doi.org/10.1016/j.rbre.2016.10.002

McGuire, M. and Beerman, K. (2013). Nutritional Sciences. From Fundamentals to Food. 3rd ed., p. 618–620. USA: Cengage Learning.

Mishra, A.K., Gajjar, K. and Patel, K. (2016). Association between body mass index and bone mineral density among healthy women in India. *International Journal of Medical Research and Health Sciences*, 5(4), 156–160.

Mithal, A. and Kaur, P. (2012). Osteoporosis in Asia: A call to action. *Current Osteoporosis reports*, 10, 245–247. https://doi.org/10.1007/s11914-012-0114-3

Moayyeri, A., Luben, R.N., Wareham, N.J. and Khaw, K.-T. (2012). Body fat mass is a predictor of risk of osteoporotic fractures in women but not in men: a prospective population study. *Journal of Internal Medicine*, 271(5), 472–480. https://doi.org/10.1111/j.1365-2796.2011.02443.x

Patel, H.P., Dawson, A., Westbury, L.D., Hasnaoui, G., Syddall, H.E., Shaw, S., sayer, A.A., Cooper, C., and Dennison, E.M. (2018). Muscle mass, muscle morphology and bone health among community-dwelling older men: findings from the Hertfordshire Sarcopenia Study (HSS). *Calcified Tissue International*, 103, 35–43. https://doi.org/10.1007/s00223-018-0388-2

Pi-sunyer, X. (2014). Obesity: criteria and classification. *Proceedings of the Nutrition Society*, 59(4), 505–509. https://doi.org/10.1017/S0029665100000732

Quiros-Roldan, E., Brianese, N., Raffetti, E., Focà, E., Pezzoli, M.C., Bonito, A., Ferraresi, A., Lanza, P., Porcelli, T., and Castelli, F. (2017). Comparison between the gold standard DXA with calcaneal quantitative ultrasound based-strategy (QUS) to detect osteoporosis in an HIV infected. *The Brazilian Journal of Infectious Diseases*, 21(6), 581-586. https://doi.org/10.1016/j.bjid.2017.08.003

Rochmah, N., Probosari, E. and Dieny, F.F. (2017). Hubungan asupan vitamin D dan kalsium dengan kadar glukosa darah puasa wanita obesitas usia 45-55 tahun. *Journal of Nutrition College*, 6(4), 285–292. [In Bahasa Indonesia]. https://doi.org/10.14710/jnc.v6i4.18663

Saitoglu, M., Ardicoglu, O., Ozgocmen, S., Kamanli, A. and Kaya, A. (2007). Osteoporosis risk factors and association with somatotypes in males. *Archives of Medical Research*, 38(7), 746–751. https://doi.org/10.1016/j.arcmed.2007.03.009

Silva, A.C.V., da Rosa, M.I., Fernandes, B., Lumertz, S., Diniz, R.M. and dos Reis Damiani, M.E.F. (2015). Factors associated with osteopenia and osteoporosis in women undergoing bone mineral density test. *Revista Brasileira de Reumatologia (English Edition)*, 55(3), 223-228. https://doi.org/10.1016/j.rbre.2014.08.011

Sözen, T., Özışık, L. and Basaran, N.C. (2017). An overview and management of osteoporosis. *European Journal of Rheumatology*, 4(1), 46–56. https://doi.org/10.5152/eurjrheum.2016.048

Tan, V.P., Mcdonald, H.M., Kim, S., Nettlefold, L., Gabel, L., Ashe, M.C. and Mckay, H.A. (2014). Influence of physical activity on bone strength in children and adolescents: a systemic review and narrative synthesis. *Journal of Bone and Mineral Research*, 29(10), 2161–2181. https://doi.org/10.1002/jbmr.2254

Tirtarahardja, G., Setyohadi, B., Weynand, L.S. and Zhou, Q. (2006). Bone Mineral Density Reference Values for Indonesian Men and Women presented at American Society for Bone and Mineral Research Annual Meeting September 2006. Philadephia, USA. https://doi.org/10.1016/j.jocd.2006.04.038

Vijayakumar, R. and Busselberg, D. (2016). Osteoporosis: An under-recognized public health problem. *Journal of Local and Global Health Science*, 2016(1), 1–13. https://doi.org/10.5339/jlghs.2016.2

Wajchenberg, B.L. (2000). Subcutaneous and visceral adipose tissue: their relation to the metabolic syndrome. *Endocrine Reviews*, 21(6), 697–738. https://doi.org/10.1210/edrv.21.6.0415

FULL PAPER

