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RESEARCH ARTICLE

# The relationship of body mass index and T score in healthy and knee osteoarthritis women

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## Abstract

**Background:** Osteoarthritis (OA) is a chronic, degenerative, slowly progressive disease common in women with multiple aetiology. Osteoarthritis occurs simultaneously with the reduction in bone mineral density (BMD) while a high bone mass index (BMI) value is one of the risk factors for OA. **Objective:** The purpose of this study was to determine the effect of BMI and BMD in healthy and knee OA women. **Method:** The study was conducted in an orthopaedic outpatient clinic in 2021. This is a quantitative descriptive study with accidental cross-sectional samplings. The Mann-Whitney test was used to analyse the data. **Result:** Subjects included in the inclusion criteria obtained 74 OA and 49 control groups. The largest subjects in the OA group were aged 56-65 years old (32, 43.24%), obese (51, 68.92%), and post-menopause (49, 66.22%). At the same time, the T score category was normal (14, 18.91%), osteopenia (22, 29.73%), and osteoporosis (38, 51.35%). Statistical analysis found a significant relationship between BMI and BMD ( $p = 0.002$ ,  $p = 0.001$ ) in controls and OA groups. **Conclusion:** Disorders of BMI and BMD are indicators of risk for OA. High BMI and low BMD values occur in women with knee OA. There is a relationship between BMI and BMD in healthy and knee OA women.

## Introduction

Osteoarthritis (OA) is the most common chronic arthritis of unknown multi-etiology. OA involves one or more diarthrodial joints, including small (hand) and large (knee and hip) joints (CDC, 2020). This disease is slowly progressive, characterised by changes in the structure of the joint cartilage (hyaline cartilage), thickening of the joint plates (sclerotic), the appearance of bony protrusions on the surface of the bones at the edges of the joints (osteophytes),

stretching of the joint capsule, muscle weakness (Hunter & Bierma-Zeinstra, 2019). Based on the Riskesdas (Basic Health Research) Indonesia report, osteoarthritis is a joint disease, and the prevalence of joint disease based on a doctor's diagnosis at age  $\geq 15$  is 7.3%. When viewed from the characteristics, the highest prevalence was at age  $> 75$ , namely 18.95%, female sufferers (8.46%) compared to men (6.13%). (Riskesdas, 2018). Therefore, a better understanding of OA risk factors is needed.

Several risk factors, including elderly women, high body mass index (BMI), and joint injuries, have been identified as associated with OA (Silverwood, 2015; Park, 2018). Decreased muscle mass, thinning of the cartilage layer, and thickening of the subchondral often occur in the elderly. The decrease in estrogen as a protector of inflammation in postmenopausal women and the occurrence of obesity will increase the joint burden in OA. The causal effect of BMI on BMD is well established; the frame adapts to the increased load placed on it topped by increasing the BMD. Alternatively, the causal pathway between BMD and BMI makes sense via the metabolism bone turnover effect (Kemp *et al.*, 2016)

According to Nevitt and colleagues, high BMD can be associated with an increased risk of OA. High bone density can increase the risk of in knee and hip OA (Nevitt *et al.*, 2010) This is a direct consequence of increased mechanical stress on the cartilage of the subchondral cortical plate (Song & Lee, 2019). This might happen because bone density does not help reduce joint load but increases the burden on joint cartilage, making it easier to tear. The T score is a diagnostic screening that can be done to determine the condition of bone mineral density. The smaller the T score, the lower the bone density, and the higher the incidence of osteoporosis, but not necessarily the higher the incidence of OA. An increase in BMI does not necessarily increase BMD, and vice versa. The complex relationship between OA and osteoporosis is now increasingly being revealed. However, further research is still needed to understand its pathogenesis. Few studies still provide results about the relationship between BMI and BMD in knee OA women because all the scientific information written above can occur in healthy people. This study will explore the relationship between BMI and BMD in healthy and knee OA women.

## Methods

### Design

The data was collected in May 2021 and July 2022 following study ethical approval No. 44/LE/2021 and No. 234/EC/ KEPK/08/2021. The OA group (n=74) was conducted in orthopaedic outpatient wards, and the control group (n=49) was collected from volunteers who did not have clinical disorders of knee joint pain and crepitus. The number of recruited subjects in each hospital was planned proportionally according to the hospitals' prevalence of knee OA patients, i.e. 56% Brawijaya Army Hospital Surabaya and 44% Aisyiyah Islamic Hospital Malang, Indonesia.

Orthopaedic specialists selected all of the subjects in the study following the guidelines of the American College of Rheumatology 2019 (Kolasinski *et al.*, 2020). This study was descriptive quantitative with cross-sectional, and the subjects were recruited based on accidental sampling, who met the inclusion and exclusion criteria. The inclusion criteria were women aged 45-70 years old, diagnosed with knee OA Kelgreen Lawrence (KL) level 1 or 2, evidenced by radiographic photos of the knee not falling for the last month. In contrast, the exclusion criteria were knee OA patients with complications of autoimmune disease, taking a weight loss diet program, and consuming corticosteroids every day for the last month. The patients' characteristics data (age, menopause, BMI, T-score) were collected during the participant's interview. BMD was measured directly in calcaneus using the quantitative ultrasound bone densitometry, and BMI was obtained from measurement anthropometry, including height and weight. The data was analysed statistically using Mann-Whitney tests ( $p < 0.05$ ), considered significantly different.

## Results

In this study, the total number of patients recruited was 123, divided into 49 subjects assigned to the control group and 74 to the OA group. Matching data on age, menopause, and BMI, there was no significant difference using the Mann-Whitney analysis (Table I). This shows the subject is homogeneous.

**Table I: Characteristics of patients in the control and OA groups**

Characteristics	Frequency (%)		p-value (T score)
	Control (n=49)	OA (n=74)	
<b>Age</b>			0.79
≤ 55	47 (95.92)	23 (31.08)	
56- 65	2 (4.08)	32 (43.24)	
≥ 65		19 (25.68)	
<b>BMI (kg/m<sup>2</sup>)</b>			0.091
Normal	19 (38.78)	10 (13.51)	
Overweight	9 (18.37)	13 (17.57)	
Obese	21 (42.86)	51 (68.92)	
<b>Menopause</b>			0.057
Not	47 (95.92)	25 (33.78)	
Yes	2 (4.08)	49 (66.22)	
<b>T score</b>			
Normal	37 (75.51)	14 (18.91)	
Osteopenia	12 (24.49)	22 (29.73)	
Osteoporosis		38 (51.35)	

As a note, there are differences in the characteristics of the control and OA groups, but the T score data for both groups are in the same category. Increased BMI and menopausal status as factors for the occurrence of OA were proven in this study, but elderly age and increased BMD (T score) were not proven well. The statistical test showed a significant difference between BMI and T scores in the control and OA groups ( $p = 0.002$ ;  $0.001$ ) (Table II). There is an increase in BMI and a decrease in BMD in women with knee OA.

**Table II: Association of BMI and T score in the control and OA groups**

Variables	Control (n=49)	OA (n= 74)	p-value
	Mean±SD		
BMI	25.17±0.19	27.65±0.59	0.002
T score	(-0.76±0.40)	(-2.22±1.55)	0.001

## Discussion

In this study, Pre-elderly was the most common characteristic of the OA group, who were probably menopausal-related women. The elderly have a significant role in OA (Hunter & Bierma-Zeinstra, 2019), and menopause can affect the occurrence of OA through estrogen deficiency (Gao *et al.*, 2015). Its receptor dysregulation expression is also involved in the pathogenesis of OA (Tang *et al.*, 2021). Estrogen deficiency, demonstrated in an experimental postmenopausal mouse model, results in subchondral bone resorption and articular cartilage degeneration (Xu *et al.*, 2019).

Other characteristics found in this study were high BMI and low T scores. An unhealthy lifestyle, including food choices that are consumed, can cause overweight or obesity as the most significant risk factor for OA, which results in an excessive burden on joints and damage to the cartilage (Bennell *et al.*, 2019). However, the reduction in T score in the osteoporosis category could not be adjusted for specific causes of OA because the previously reported association between BMD and osteoarthritis may be the result of bias or confounding factors inherent in observational studies (Hartley *et al.*, 2022), such as body weight, physical activity, reverse causation, a small number of small-size studies, and selection bias. In this study, menopause confounding factors could bias OA results because a decrease in the T score should have occurred in women OA patients. In practice, it can be applied that controlling the occurrence of OA both clinically and radiographically is necessary because the

risk factors for OA are different both internally (genes, gender, age, menopause, BMI, BMD) or externally (trauma, activity, joint load, and others). Examination of tibial plateau morphological changes may be a better parameter having fewer confounding factors for observing the effect of BMD on knee OA (Shun *et al.*, 2021). The risk factors for OA can influence each other with various pathogenesis mechanisms. Osteoporosis alone as a parameter for the development of OA of the knee is not ideal for clinical setting and diagnosis. Osteoporosis allows narrowing of the joint space, although this can be affected by the laxity of the ligaments, meniscus injuries, use of cartilage, and especially weight-bearing status (Razek & El-Basyouni, 2016; Mochizuki *et al.*, 2019).

The results of this study differ from Nevitt (2010), who said that a high BMD is an indicator of OA. Many factors can influence differences many factors can influence differences, but the most important is the difference in lifestyle. The pattern of human life tends to be influenced by the physical conditions of the local environment. Lifestyle can affect a person's behaviour and attitudes, including activity patterns. High activity can be a risk factor for OA and other musculoskeletal disorders. The risk of osteoporosis is higher in less active people with low BMI and BMD values. Internal factors that affect OA and osteoporosis are cytokines, adipokines, and hormones. Leptin can reduce the risk of osteoporosis but increase the risk of osteoarthritis (Kambayana, 2017). The relationship between BMI and BMD in OA women requires a lot of research data carried out in many places with different subject characteristics. Internal and external factors that affect the musculoskeletal should be adequately investigated.

## Conclusion

Disorders of BMI and BMD are indicators of risk for OA. High BMI and low BMD values occur in women with knee OA. A relationship exists between BMI and T score in healthy and knee OA women. Further study is needed to determine the risk factors for OA associated with BMI and BMD values.

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