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Original Research

Impact of BMI on Knee Osteoarthritis WOMAC Severity in Adults: A Cross-Sectional Study

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Abstract

Background: Knee osteoarthritis (OA) is a degenerative joint disease that most often causes pain and disability in adults and the elderly. Risk factors for OA progression include age, gender, physical activity, and body mass index (BMI). Increased BMI is known to contribute to increased mechanical load on the knee joint and trigger inflammation, which can exacerbate OA severity.

Objective: To assess the relationship between body mass index (BMI) and the severity of knee osteoarthritis in adult patients.

Methods: This is a cross-sectional analytical study conducted at Rheumatology Clinic of Dr. Soetomo General Hospital, Surabaya, in 2019. A total of 42 patients diagnosed with knee OA who met the inclusion and exclusion criteria were enrolled. OA severity was assessed using the WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index) score, while BMI was calculated based on WHO standards and categorized into normal and high (overweight/obese). Analysis of the relationship between BMI and the severity of OA was carried out using the Fisher's Exact Test, with a p value < 0.05 considered significant.

Results: Most patients with normal BMI had moderate-severe OA (77.8%), while patients with high BMI were more likely to have very severe OA (58.3%). Fisher's Exact Test showed a significant association between BMI and OA severity (p = 0.0285). Patients with high BMI were more likely to have very severe OA compared to patients with normal BMI (OR ≈ 4.9; 95% CI ≈ 1.1–21.5).

Conclusion: There was a significant association between increasing BMI and the severity of knee osteoarthritis. These findings emphasize the importance of weight control as part of the prevention and management strategy for knee OA in adult patients.

Keyword: Osteoarthritis, degenerative joint disease, WOMAC, body mass index

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1. INTRODUCTION

Osteoarthritis (OA) is one of the most common degenerative joint diseases, often causing persistent pain and disability, especially in older adults. Global Burden of Disease (GBD) data shows that the number of OA cases continues to increase sharply over time. By 2020, the number of people with OA is estimated to reach hundreds of millions globally, with knee OA being a major contributor to this overall burden. The prevalence of knee OA varies depending on how the condition is defined (based on symptoms or radiology), population characteristics, and the survey methods used. Several international and national reports consistently show that the prevalence of knee OA increases with age, particularly in middle-aged and elderly groups. A similar trend is also seen in low and middle income countries, including Indonesia, where cases of knee OA have been reported to have increased steadily in recent decades (1).

Knee OA significantly impacts quality of life, primarily due to chronic pain, functional limitations, and decreased ability to perform daily activities. Various clinical studies and surveys on health-related quality of life (HRQoL) reveal significant decline in physical and functional aspects, as well as the emergence of psychosocial burdens associated with prolonged pain and reduced social roles (2). Obesity, as measured by body mass index (BMI), has long been recognized as a major risk factor for OA. The higher a person's BMI, the greater their likelihood of developing knee OA, and the more rapidly the condition progresses. Two main mechanisms underlie this: first, increased mechanical loading on the knee joint, accelerating cartilage and subchondral bone damage; second, the inflammatory and metabolic effects of adipose tissue, which produces adipokines and cytokines that trigger synovial inflammation and joint degradation.

A meta-analysis reported that a 5 kg/m² increase in BMI can increase the risk of knee OA by approximately 35%, and obese individuals are 4–5 times more likely to develop OA than those with a normal BMI (3). The GBD 2021 report also ranked obesity as one of the most influential risk factors contributing to the global burden of OA, particularly in countries with a high obesity prevalence (1). One widely used instrument to assess the level of OA symptoms, including pain, stiffness, and functional limitations, is the WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index). This instrument has been proven reliable and valid in various languages.

However, in some countries, radiological assessment is still more often used to determine the severity of OA objectively. The WOMAC provides a subjective assessment of the degree of OA

severity through three main components; pain, stiffness, and physical function. Although many studies utilize the WOMAC as an evaluation tool in clinical interventions, few actually use the WOMAC score or WOMAC subscales as the primary variable in describing the severity of OA in adult populations, particularly in middle- or low-income countries (4). Based on this, this study will use the WOMAC as the primary tool to measure the severity of knee OA and assess the relationship between body mass index (BMI) and the severity of knee osteoarthritis in adult patients.

2. METHOD

Research Design

This is an analytical study with a cross-sectional design. The study was conducted to analyze the relationship between body mass index (BMI) and the severity of knee osteoarthritis in adult patients based on the WOMAC score.

Population and Sample

The study population was adult patients diagnosed with knee osteoarthritis who visited the Rheumatology Clinic at Dr. Soetomo Hospital, Surabaya. Sampling was conducted in 2019, with a total of 42 patients who met the inclusion and exclusion criteria. Inclusion criteria included patients aged 18 years and above with a clinical diagnosis of knee osteoarthritis based on examination by a rheumatologist. Exclusion criteria included patients with a history of previous knee surgery or incomplete clinical data.

Research Variables

The primary exposure variable was body mass index (BMI), categorized according to WHO standards into normal, overweight, and obese. We further subdivided the overweight and obese categories into high BMI. The outcome variable was the severity of knee osteoarthritis, measured using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score, which includes three subscales: pain, stiffness, and functional limitations. We categorized the WOMAC criteria into two groups: moderate-severe and very severe for data analysis. Several covariates were also analyzed, including age, gender, history of comorbidities, and patient physical activity level.

Data Collection Procedure

BMI was measured by dividing body weight (kg) by the square of height (m^2). BMI categories were determined according to WHO criteria. Osteoarthritis severity was assessed using the WOMAC questionnaire, as shown in Table 1, which has been validated in Indonesian and includes assessments of pain, stiffness, and functional limitations. Additional data regarding age, gender, and comorbidities were obtained through structured interviews and patient medical records (Table 2).

Statistical Analysis

Descriptive analysis was conducted to describe the

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characteristics of the study subjects. Numeric data are presented as mean ± standard deviation or median with interquartile range (IQR), while categorical data are presented as frequencies and percentages. Bivariate analysis was conducted to assess the relationship between BMI and osteoarthritis severity using the Fisher's Exact Test. Next, the Relative Risk (RR), Odds Ratio (OR), and 95% Confidence Interval (CI) were calculated. All statistical analyses were performed using *GraphPad Prism* software.

Ethical Considerations

This study has received approval from the Health Research Ethics Committee of Dr. Soetomo General Hospital, Surabaya (1056/KEPK/III/2019).

All participants received an explanation of the study's objectives and procedures and signed a written informed consent

TABEL 1. WOMAC Questionnaire And Assessment Criteria

The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)

Pain	0 None	1 Slight	2 Moderate	3 Very	4 Extremely
1. Walking	o	o	o	o	o
2. Stair climbing	o	o	o	o	o
3. Nocturnal	o	o	o	o	o
4. Rest	o	o	o	o	o
5. Weight bearing	o	o	o	o	o
Stiffness					
1. Morning stiffness	o	o	o	o	o
2. Stiffness occurring later in the day	o	o	o	o	o
Physical Function					
1. Descending stairs	o	o	o	o	o
2. Ascending stairs	o	o	o	o	o
3. Rising from sitting	o	o	o	o	o
4. Standing	o	o	o	o	o
5. Bending to Floor	o	o	o	o	o
6. Walking on flat surface	o	o	o	o	o
7. Getting in/out of car	o	o	o	o	o
8. Going shopping	o	o	o	o	o
9. Putting on socks	o	o	o	o	o
10. Lying in bed	o	o	o	o	o
11. Talking off socks	o	o	o	o	o
12. Rising from bed	o	o	o	o	o
13. Getting in/out bath	o	o	o	o	o

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form before participating.

3. RESULTS

A total of 42 patients with knee osteoarthritis participated in this study, consisting of 18 patients with a normal body mass index (BMI) and 24 patients with a high BMI (overweight and obese). According to WHO (13), overweight and obesity are defined as abnormal or excessive fat accumulation that poses a health risk. A BMI over 25 is classified as overweight, and a BMI over 30 as obese both considered categories of high BMI. Based on the severity of osteoarthritis, assessed using the WOMAC score, the majority of patients with a normal BMI had moderate to severe severity (77.8%), while only 22.2% were classified as very severe. Conversely, in the high BMI group, the proportion of patients with very severe osteoarthritis was higher, at 58.3%, compared with 41.7% in the moderate to severe category (Table 3).

Analysis of the relationship between BMI and osteoarthritis severity using Fisher's exact test showed statistically significant results ($p = 0.0285$). Patients with high BMI were more likely to have very severe OA compared to patients with normal BMI (OR ≈ 4.9; 95% CI ≈ 1.1–21.5). These results indicate a significant association between BMI and knee osteoarthritis severity, with patients with a high BMI tending to have a more severe disease severity than those with a normal BMI.

Table 2. Data related to gender, age, and history of comorbid diabetes mellitus in patients

Gender Characteristics	N (%)
Male	5 (11.9%)
Female	37 (88.1%)

Age Characteristics	N (%)	Min	Max	Mean
41 – 50	5 (11,9%)	43	88	59,8
51 – 60	18 (42,8%)			
61 – 70	15 (35,7%)			
71 – 80	2 (4,7%)			
81 – 90	2 (4,7%)			

History of Diabetes Mellitus	N (%)
Yes	10 (23,8%)
No	32 (76,2%)

4. DISCUSSION

Several studies have shown that female gender, older age, and especially higher BMI are factors consistently associated with the severity of knee osteoarthritis (OA). A study in southern Bosnia and Herzegovina found that women experienced more pain, stiffness, and higher WOMAC total scores, while older age and

higher BMI were also associated with increased OA severity. BMI was the strongest predictor, with significant increases across all WOMAC subscales; pain, stiffness, and functionality. In addition to biological factors, sociodemographic variables such as education level and physical activity also played a role. Higher education and higher levels of physical activity were each associated with lower WOMAC functional scores, emphasizing the importance of interventions that address lifestyle factors. Raud et al. (2020) confirmed a linear relationship between obesity severity and decreased physical function.

WOMAC scores increased with increasing obesity category, indicating a combination of increasingly severe pain and decreased mobility. Devi et al.'s (2024) study corroborated these findings, showing that higher BMI was significantly associated with more severe pain (p=0.001; OR 3.93). OA severity also showed a strong association with pain intensity (p<0.001; OR 3.96). BMI and OA stage together explained 37.7% of the variation in pain levels, highlighting the interacting roles of mechanical and inflammatory mechanisms.

Biologically, obesity contributes through increased joint pressure and inflammatory mechanisms, including the production of proinflammatory cytokines from intra-articular adipose tissue. Consistent with this, Shumnalieva et al. (2023) reported that increasing BMI was associated with increased pain scores, decreased function, and radiographic progression of knee OA. Overall, findings from various studies confirm that BMI is a major risk factor for worsening pain and disability in knee OA, making weight management interventions and increasing physical activity key strategies in the management of this condition. An increase in body mass index (BMI), often associated with obesity, increases the mechanical load on the knee

Table 3. Number of patients based on BMI and severity of OA on the WOMAC Scale

BMI	Middle-High	Very High	Total
Normal	14 (77,8%)	4 (22,2%)	18 (100%)
High	10 (41,7%)	14 (58,3%)	24 (100%)
Total	24	18	42

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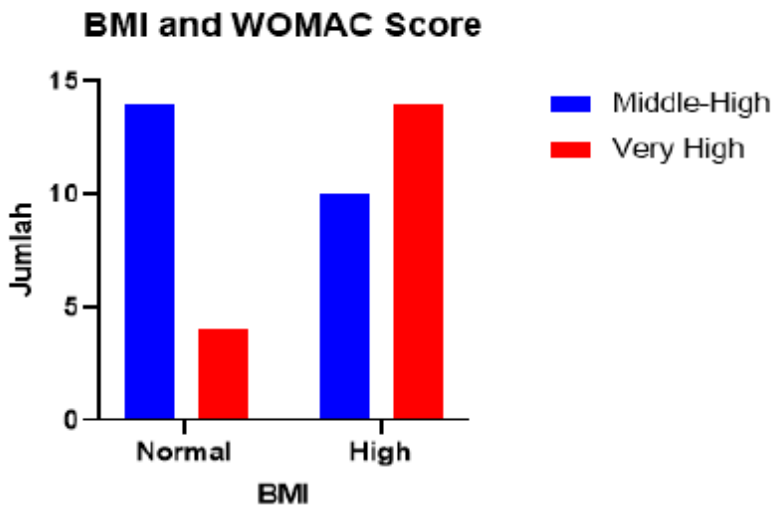

Figure 1. Bar Chart Showing That High BMI Has More Patients With Very Severe Severity Compared To Normal BMI

joint, accelerating the degenerative process in the articular tissue.

Biomechanically, any increase in body weight increases the compressive forces on cartilage, particularly in the medial compartment of the knee, which accelerates wear and reduces cartilage thickness and quality. This change in load can also alter joint motion patterns and alignment, leading to uneven pressure distribution and accelerating structural degradation.

Beyond mechanical stress, adiposity triggers systemic and local inflammatory pathways that exacerbate joint damage. Adipose tissue including visceral fat and the infrapatellar fat pad produces adipokines and proinflammatory cytokines (e.g., leptin, TNF-α, IL-6, IL-1β) that enhance the synovial inflammatory response and activate proteolytic enzymes such as MMPs and ADAMTS. Activation of these enzymes damages the extracellular matrix and shifts the chondrocyte metabolic balance toward degradation, accelerating matrix component loss and declining cartilage biomechanical function.

The interaction between mechanical loading and inflammatory mechanisms creates a pathogenic cycle: mechanical stress damages cartilage and releases mediators that amplify inflammation, while inflammatory mediators increase tissue susceptibility to mechanical stress.

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Consistency in clinical findings including increased levels of leptin and TNF-α in synovial fluid in more severe cases of OA supports the importance of both pathways in the progression of knee osteoarthritis. From a management perspective, approaches that lower BMI (e.g., weight loss and increased physical activity) have a dual effect: reducing mechanical stress on the articular surface and decreasing the burden of inflammatory mediators.

Therefore, interventions targeting weight loss and improving adipose tissue composition are key strategies for slowing OA progression and improving functional symptoms.

5. CONCLUSION

The results of this study indicate that higher body mass index (BMI) is significantly associated with increased severity of knee osteoarthritis (OA) in adult patients, as measured by the WOMAC score. These findings strengthen the evidence that obesity and overweight are important factors contributing to OA progression through increased mechanical loading on joints and systemic inflammatory mechanisms.

From a clinical perspective, weight management interventions should be an integral part of knee OA prevention and management strategies. Efforts such as nutrition education, increasing appropriate physical activity, and evidence-based weight loss

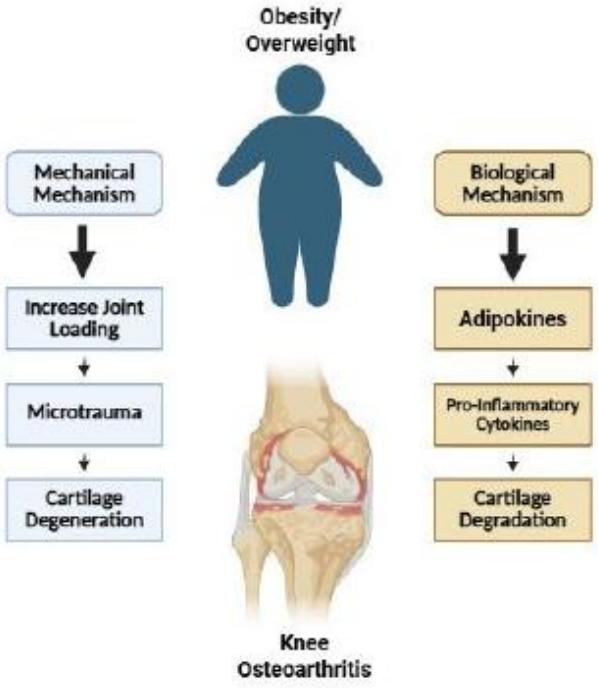

Figure 2. The mechanism of OA occurrence and its severity in overweight and obese people is associated with mechanical and biological processes.

programs can help reduce symptoms and slow disease progression. For future research, longitudinal studies with larger sample sizes and longer observation periods are recommended to identify the causal relationship between BMI and OA severity, as well as explore other factors such as body composition, systemic inflammation, and metabolic status that may influence the course of this disease.

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