

Short Report

Body Mass Index as a Determinant in the Development of Osteoarthritis: A Cross-Sectional Study

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ABSTRACT

Background: Osteoarthritis (OA) is a degenerative joint disease characterized by the progressive degradation of articular cartilage, the formation of new bone (osteophytes), and changes in synovial and subchondral tissues. These pathological changes contribute to pain, joint stiffness, and functional impairment in OA. The primary risk factors for OA include advanced age and increased body mass index (BMI). **Objective:** This study aimed to determine the association between BMI and the incidence of osteoarthritis. **Methods:** A cross-sectional analytical study was conducted among 70 participants aged >40 years from Banjar Cepaka, Badung, Indonesia, using simple random sampling method. Osteoarthritis severity was assessed using the WOMAC questionnaire, while BMI was calculated from measured height and weight. Chi-square analysis was performed to determine the associations between variables. **Results:** Osteoarthritis severity assessment using the WOMAC questionnaire demonstrated that 58.6% of the participants experienced severe symptoms, while 27.1% reported moderate symptoms. Chi-square analysis revealed a statistically significant association between BMI and osteoarthritis incidence ($p = 0.000$). The cross-tabulation showed that individuals with obesity class I had 81.2% severe osteoarthritis cases, while those with obesity class II had 83.3% severe cases and 16.7% very severe cases of osteoarthritis. **Conclusion:** In conclusion, a strong association between elevated BMI and osteoarthritis severity among adults over 40 years in rural Indonesia. The progressive relationship between increasing body weight and joint degeneration severity underscores the modifiable nature of this risk factor through weight management interventions.

KEYWORDS

Osteoarthritis, BMI, joint disease, degenerative, WOMAC questionnaire

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INTRODUCTION

Osteoarthritis (OA) is a degenerative joint disease that predominantly affects elderly individuals. This condition is characterized by progressive damage to the articular cartilage, the formation of new bone (osteophytes), and alterations in the synovial tissue and subchondral bone [1]. These pathological changes result in pain, joint stiffness, and functional impairment [2]. Although OA can affect all synovial joints, it most commonly involves the knee, followed by the hand and hip joints [3].

In Indonesia, the prevalence of joint diseases, including OA, is 7.3%. The provinces with the highest incidence of osteoarthritis are Aceh (13.26%), Bengkulu (12.11%), and Bali (10.46%) (Risksedas, 2018) [4]. The prevalence of OA continues to rise with advancing age and increasing obesity rates. Studies indicate that knee OA affects more than 22% of the global population aged > 40 years [5]. In addition to age, other risk factors, such as elevated body mass index (BMI), a history of joint trauma, and excessive physical activity involving the joints, may accelerate the degenerative process [6].

One of the major risk factors contributing to the incidence of knee osteoarthritis (OA) is an elevated body mass index (BMI). BMI is a widely used indicator of nutritional status and represents the ratio of body weight to body height. Individuals with a high BMI, particularly those classified as overweight or obese, are at a significantly greater risk of developing knee OA. This association is attributed to two primary mechanisms: mechanically, excess body weight places an additional load on the knee joint, particularly the medial compartment, leading to increased articular stress, cartilage degeneration, and joint wear. In parallel, adipose tissue contributes to systemic low-grade inflammation through the secretion of proinflammatory cytokines [7].

Numerous studies have demonstrated a significant correlation between a high BMI and the occurrence of knee OA. For example, Aldo and Gustin [8] reported that among 65 obese respondents, 49 individuals (75.4%) were diagnosed with knee OA. Furthermore, Silverwood et al. (2022) reported that individuals with obesity have a two- to threefold greater risk of developing knee OA than those with a normal body weight [9]. In addition to mechanical loading, obesity-related metabolic factors also play a role in OA pathogenesis. Excess adipose tissue actively produces proinflammatory cytokines, such as interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF- α), both of which contribute to cartilage degradation and synovial inflammation, accelerating the degenerative process [10].

This study was conducted in Banjar Cepaka, Badung, Bali, which has a population of 650 people, with an estimated 340 individuals classified as adults and elderly individuals. This proportion indicates that more than half of the population falls within an age group at increased risk of musculoskeletal disorders, including OA. Among the elderly population, this risk becomes even more complex due to age-related changes, including musculoskeletal decline, reduced physical activity, and alterations in body composition associated with aging. These factors may exacerbate joint instability and further limit mobility, leading to a vicious cycle of inactivity, weight gain, and deterioration of joint health.

The findings of this study are expected to raise public awareness about the importance of maintaining an ideal body weight as a preventive measure against OA while also supporting the promotion and prevention of health efforts within the community. Understanding the relationship between BMI and knee OA, particularly among older adults, is essential for developing effective prevention strategies, promoting early diagnosis, and implementing targeted management interventions aimed at reducing disease burden and preserving functional independence.

MATERIALS AND METHODS

Study design, setting and population

This study applied an analytical method with a cross-sectional design and was conducted in June 2024 in Banjar Cepaka, Badung, Indonesia. The study was conducted in Banjar Cepaka, Badung, Indonesia. Primary data were collected through the distribution of questionnaires. These questionnaires were given to respondents and contained questions related to individuals and

variables associated with body mass index (BMI) and osteoarthritis. This study utilized an open-ended questionnaire, allowing respondents to answer questions by choosing from several available options that best represented their experiences or circumstances

Variables and operational definitions

The study addressed two main variables: (a) the independent variable, body mass index, which was the measurement of body weight in kilograms (kg) divided by height in meters squared (BB/TB^2), to determine a person's nutritional status. Body mass index categories (underweight, normal, overweight, and obese). (b) Dependent variables: Osteoarthritis in individuals was measured via the The Western Ontario and McMaster Universities Arthritis Index (WOMAC) questionnaire with four grades (mild, moderate, severe, and very severe).

Sample technique and sample selection

This study employed simple random sampling to reduce selection bias and enhance the representativeness of the target population of the study. We chose simple random sampling instead of consecutive sampling because of the large number of eligible records and to prevent temporal clustering. Participants were included on the basis of the following criteria: (a) aged > 40 years; (b) living in Banjar Cepaka; (c) willing to participate as research subjects; and (d) having osteoarthritis. Participants were excluded on the basis of the following criteria: (a) had dementia, (b) had severe psychological disorders that interfere with dementia, and (c) had a history of head trauma.

Statistical analysis

Data analysis was conducted via SPSS version 25.0. Univariate analysis was used to present the frequency distribution and descriptive statistics of each variable, providing an overview of the sample characteristics. Bivariate analysis was performed via the chi-square test to assess the associations between independent and dependent variables. The level of statistical significance was set at $\alpha = 0.05$, meaning that any p value below this threshold was considered to indicate a statistically significant relationship. This analytical approach allowed for a clearer understanding of the correlations between variables relevant to the research objectives of this study.

Ethical considerations

This study was conducted in accordance with the formal approval of the Community Service Decree issued by *the Universitas Hindu Indonesia* (070/SKP/F. Kes/UNHI/VI/2024). Prior to participation, the respondents were informed about the purpose, methods, and voluntary nature of the study, and written informed consent was obtained from them

RESULTS

Characteristics of the respondents

The characteristics of the participants included age, sex, and body mass index (BMI). Among the 70 respondents who participated in the study, the largest age distribution was in the 60–69 years group, with a frequency of 31 (44.3%). The majority of the respondents were female, with a frequency of 41 (58.6%). The most common BMI classification was obesity class I ($n = 32$, 45.7%). The distributions of participant characteristics are shown in Table 1. The majority of participants reported severe complaints, totaling 41 individuals (58.6%), followed by moderate complaints reported by 19 individuals (27.1%), as shown in Table 2.

Correlation testing

The results of the chi-square test revealed a p value of 0.000 ($p < 0.05$), as presented in Table 3, indicating a statistically significant association between body mass index (BMI) and the incidence of osteoarthritis. This finding suggests that variations in BMI are strongly related to the likelihood of developing osteoarthritis, supporting the hypothesis that body weight is a contributing factor to joint health in the studied population.

Table 1. Characteristics of the respondents

Characteristics	Frequency (n)	Percentage (%)
Age (Years old)		
40-49	11	15.7
50-59	22	31.4
60-69	31	44.3
70-79	4	5.7
80-89	2	2.9
Gender		
Man	29	41.4
Woman	41	58.6
Body Mass Index (BMI)		
Underweight	1	1.4
Normal	11	15.7
Overweight	14	20.0
Obesity 1	32	45.7
Obesity 2	12	17.1

Table 2. Sample characteristics related to osteoarthritis

Characteristics	Frequency (n)	Percentage (%)
Mild	6	8.6
Moderate	19	27.1
Severe	41	58.6
Very Severe	4	5.7

Table 3. Correlation testing

		Osteoarthritis				p value
		Mild	Moderate	Severe	Very severe	
BMI	Underweight	0 (0%)	0 (0%)	1 (100%)	0 (0%)	0.000 ***
	Normal	4 (36.4%)	4 (36.4%)	2 (18.2%)	1 (9.0%)	
	Overweight	2 (14.3%)	9 (64.3%)	2 (14.3%)	1 (7.1%)	
	Obesity 1	0 (0%)	6 (18.8%)	26 (81.2%)	0 (0%)	
	Obesity 2	0 (0%)	0 (0%)	10 (83.3%)	2 (16.7%)	
	Total	6 (8.6%)	19 (27.1%)	41 (58.6%)	4 (5.7%)	

Remarks: *** There is a significant difference ($p < 0.05$).

DISCUSSIONS

Osteoarthritis is a progressive, chronic inflammatory disease that affects joints, with hallmark symptoms of joint pain, swelling, stiffness, and reduced mobility. These clinical manifestations can lead to significant functional limitations, ultimately diminishing the overall quality of life of affected individuals [11]. In addition to its physical impact, osteoarthritis imposes a substantial economic burden on patients and their families due to healthcare costs and loss of productivity, as well as on the broader healthcare system and society at large. In recent years, the prevalence of osteoarthritis has markedly increased, a trend that is closely associated with the global rise in life expectancy and an increasing aging population [12].

The global population is facing a rising trend of overweight, obesity, and sedentary behaviors. This harmful combination significantly contributes to the increasing prevalence of chronic, long-term health conditions, placing financial strain on healthcare systems worldwide, many of which may become unsustainable in the long term [13]. Obesity is widely recognized as a major risk factor for various chronic diseases, including metabolic syndrome. Physical inactivity is an

independent risk factor. Furthermore, prolonged periods of sitting or lying down, referred to as sedentariness, have been identified as additional contributors to poor health outcomes, regardless of other risk factors [14]. Sedentary behavior, in particular, may contribute to knee OA by inducing muscle atrophy. Furthermore, reducing sedentary time is believed to help mitigate functional limitations in individuals with knee OA and may play a role in overcoming obstacles to engaging in therapeutic exercises [15].

An elevated BMI is often linked to an imbalance between food intake and energy expenditure, particularly due to excess calorie consumption that is stored as fat. Additionally, factors such as age significantly influence muscle mass and the natural accumulation of fat. The prevalence of obesity tends to rise steadily until the age of 44, after which it typically begins to decline between the ages of 45 and 54 [16]. A supporting study conducted by Nata et al. (2020) revealed that most elderly participants had an elevated body mass index (BMI). The study revealed a significant association between BMI and osteoarthritis, with a p value of 0.021 ($p \leq 0.05$). The results also demonstrated that respondents with a higher BMI were predominantly individuals over 40 years of age. This condition is attributed to factors such as dietary patterns, physical activity levels, and other lifestyle-related influences [17]. Previous studies have shown a link between dietary habits and markers of inflammation. Specifically, the Western dietary pattern is associated with elevated levels of proinflammatory cytokines, including interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF- α) [18].

This study demonstrated that participants classified as obese on the basis of their body mass index (BMI) were more likely to experience osteoarthritis, with a greater proportion presenting with severe joint degeneration. These findings suggest a strong correlation between increased body weight and the severity of osteoarthritis symptoms, likely due to the excessive mechanical load placed on weight-bearing joints and potential metabolic and inflammatory processes associated with adiposity. These results underscore the critical need for early intervention in weight management as a preventive measure to reduce the risk and progression of severe osteoarthritis, particularly in obese individuals [19].

The exact etiology of the causal relationship between body mass index (BMI) and osteoarthritis remains unclear. However, several studies have proposed that individuals with an elevated BMI are subject to increased mechanical loading on joints, particularly those that bear weight, such as the knees and hips. This excessive joint stress may accelerate the degeneration of articular cartilage, thereby contributing to the onset and progression of osteoarthritis. In addition to mechanical factors, metabolic and inflammatory pathways associated with obesity may play a role in the disease process [20]. Obesity is a significant risk factor associated with an increased incidence of hip and knee osteoarthritis (OA). In knee OA, excess body weight contributes to abnormal mechanical loading of the joint, accelerating the degeneration of the articular cartilage and damaging the surrounding ligaments. This biomechanical stress ultimately promotes OA development [21]. In addition, obesity may contribute to the development of inflammation by increasing the production of metabolic intermediates derived from lipid metabolism, which can promote inflammatory responses within joint tissues and potentially lead to the onset and progression of osteoarthritis [22].

Age, sex, and joint injury are also recognized as major risk factors for the development of osteoarthritis. Overweight and obesity stand out as modifiable risk factors that are more manageable and preventable through lifestyle interventions [23]. Although factors such as age and sex are nonmodifiable, maintaining a healthy body weight through balanced nutrition and regular physical activity can significantly reduce mechanical stress on joints and lower the risk of osteoarthritis. This highlights the importance of public health initiatives focused on weight management as a key strategy for preventing the onset and progression of osteoarthritis [24,25].

Clinical implications

Healthcare providers should prioritize BMI assessment and weight management counseling in patients over 40 years of age as a primary osteoarthritis prevention strategy. Early identification of overweight and obese individuals enables targeted interventions before severe joint degeneration develops. Weight reduction programs should be integrated into routine clinical

practice, particularly given that 81.2% of participants with obesity class I and 83.3% of those with obesity class II presented with severe osteoarthritis symptoms. The progressive relationship between BMI categories and disease severity supports the implementation of structured weight loss protocols as a first-line treatment, potentially reducing the need for advanced interventions, such as joint replacement surgery, and improving long-term functional outcomes in aging populations.

Limitations

This study used a cross-sectional design to observe the relationship between body mass index (BMI) and osteoarthritis (OA) at a single point in time. Consequently, it was not possible to establish a causal relationship between BMI and OA occurrence on the basis of this design. Data on osteoarthritis symptoms were partially collected through interviews or questionnaires, making them highly dependent on the participants' memory and honesty. This reliance may lead to information biases. Moreover, the study was conducted exclusively in Banjar Cepaka; therefore, the findings may not be generalizable to broader populations with different geographic, social, or cultural characteristics. OA is also influenced by various factors, such as a history of joint injury, physical activity, and genetic predisposition. Several of these factors were not examined in depth in this study and may serve as potential confounding variables in future studies.

CONCLUSIONS

The results of this study revealed a significant association between body mass index (BMI) and the incidence of osteoarthritis. Individuals with higher BMIs are at greater risk of developing osteoarthritis, likely due to the increased mechanical load on weight-bearing joints, such as the knees and hips, as well as potential metabolic and inflammatory factors linked to excess adipose tissue. This finding underscores the multifactorial role of body weight in OA pathogenesis and highlights the need for targeted interventions focused on weight management. Promoting a healthy lifestyle through balanced nutrition and regular physical activity may serve as an effective strategy for reducing the risk and progression of osteoarthritis, especially in elderly populations. Future research is recommended to further explore the causal mechanisms and evaluate the impact of weight reduction programs on joint health outcomes.

CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

AUTHOR CONTRIBUTIONS

Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data Curation, Writing-Original Draft, Writing -Review & Editing, Visualization, and Supervision: AAIIFA and PAMR.

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DECLARATION OF ARTIFICIAL INTELLIGENCE USE

We hereby confirm that no artificial intelligence (AI) tools or methodologies were utilized at any stage of this study, including during data collection, analysis, visualization, or manuscript preparation. All work presented in this study was conducted manually by the authors without the assistance of AI-based tools or systems.

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