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The Relation between Body Mass Index and Knee Osteoarthritis in Pre-Elderly to Elderly at Orthopedic Poly of Dr. Mohamad Soewandhie Regional Public Hospital Surabaya

Yoga Prana Putra Santoso[1], Minarni Wartiningsih[2], and Bimo Sasono[3]

[1] Faculty of Medicine, Universitas Ciputra, Surabaya, Indonesia
[2] Department of Public Health, Faculty of Medicine, Universitas Ciputra, Surabaya, Indonesia
[3] Dr. M. Soewandhie Hospital Surabaya, Indonesia

Corresponding author: Minarni Wartiningsih (e-mail: minarni.wartiningsih@ciputra.ac.id)

ABSTRACT Osteoarthritis represents a significant degenerative joint disorder characterized by progressive cartilage deterioration and inflammatory processes, predominantly affecting elderly populations. While multiple risk factors contribute to osteoarthritis development, obesity has emerged as a critical modifiable determinant. Previous research in Surakarta demonstrated that individuals with BMI >25 exhibit a 4.9-fold increased risk for osteoarthritis compared to those with normal BMI (18.5-25.0). However, limited studies have examined the specific relationship between BMI and osteoarthritis severity in Indonesian healthcare settings. This study aimed to investigate the association between body mass index and knee osteoarthritis severity among pre-elderly to elderly patients attending the orthopedic outpatient clinic at Dr. Mohamad Soewandhie Regional Public Hospital, Surabaya. A cross-sectional observational study was conducted from August to November 2022, utilizing non-probability purposive sampling. Medical records of 38 eligible patients with confirmed knee osteoarthritis diagnoses were systematically reviewed. Data collection encompassed demographic characteristics, anthropometric measurements, and osteoarthritis grading based on clinical assessments. Statistical analysis employed Spearman's rank correlation to examine relationships between BMI categories and osteoarthritis severity grades. The study population comprised predominantly elderly patients (>60 years: 65.8%) with female predominance (73.7%). Most participants presented with grade II osteoarthritis (50.0%) and mild overweight BMI category (36.8%). Spearman's correlation analysis revealed a significant positive correlation between BMI and osteoarthritis severity ($r=0.554$, $p<0.001$). Patients with obesity demonstrated substantially higher proportions of severe osteoarthritis (grades III-IV) compared to those with normal or underweight BMI classifications. This investigation establishes a significant positive correlation between elevated BMI and increased knee osteoarthritis severity in elderly populations. These findings underscore the importance of weight management strategies in osteoarthritis prevention and treatment protocols, suggesting that BMI-targeted interventions may effectively mitigate disease progression and enhance patient quality of life outcomes.

INDEX TERMS Body Mass Index, Knee Osteoarthritis, Elderly Patients, Cross-sectional Study, Indonesia

I. INTRODUCTION

Knee osteoarthritis (OA) is a prevalent degenerative joint disease characterized by progressive cartilage degradation, subchondral bone remodeling, synovial inflammation, and osteophyte formation, leading to chronic pain, functional limitations, and reduced quality of life, particularly among elderly populations [1], [2]. As a leading cause of global disability, OA affects millions worldwide, with significant socioeconomic implications due to healthcare costs and productivity losses [3], [4]. In 2021, the global burden of OA was estimated to impact over 500 million individuals, with knee OA being the most common form, contributing to substantial morbidity in aging populations [5]. The chronic and progressive nature of OA necessitates a deeper understanding of modifiable risk factors to develop effective prevention and management strategies [6].

Body mass index (BMI) is a critical modifiable risk factor for knee OA, as excess body weight increases mechanical stress on weight-bearing joints and promotes systemic inflammation through adipose tissue-derived cytokines [7], [8]. Obesity, defined as a BMI ≥ 30 kg/m², is associated with a significantly higher risk of OA, with studies reporting a 4–5 times greater likelihood of knee OA in obese individuals compared to those with normal BMI (18.5–25.0 kg/m²) [9], [10]. The biomechanical overload from excess weight accelerates cartilage degradation, while obesity-related

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metabolic syndrome, characterized by insulin resistance and elevated inflammatory markers, exacerbates OA severity [11], [12]. Recent research highlights the role of visceral adiposity in promoting pro-inflammatory pathways, further aggravating synovial inflammation and cartilage loss [13], [14]. Additionally, gender-specific factors, such as hormonal influences in women, may modulate OA susceptibility, with female patients showing a higher prevalence of severe OA [15]. This studying of OA include advanced imaging techniques, such as magnetic resonance imaging (MRI) for cartilage assessment, and biomarker analysis to quantify inflammatory and metabolic pathways [16]. Cross-sectional and cohort studies have utilized statistical methods like Spearman's correlation and logistic regression to explore associations between BMI and OA severity, often incorporating demographic variables like age and gender [17]. However, these studies predominantly focus on Western populations, with limited data from developing countries, particularly in Southeast Asian healthcare settings [18].

Despite the established BMI-OA link, there remains a significant research gap in investigating this relationship within specific regional contexts, such as Indonesian outpatient clinics. While studies in other regions have demonstrated correlations between obesity and OA severity, few have explored the graded severity of knee OA across BMI categories in diverse, non-Western populations [9], [15]. Moreover, the interplay of demographic factors, such as age and gender, with BMI in modulating OA progression is underexplored in these settings, limiting the applicability of global findings to local healthcare practices [12]. This study aims to investigate the association between BMI and knee OA severity among pre-elderly to elderly patients at the orthopedic outpatient clinic of Dr. Mohamad Soewandhie Regional Public Hospital, Surabaya. Using a cross-sectional observational design, this research examines the strength and direction of the relationship between BMI categories and OA severity grades to inform targeted clinical interventions. The contributions of this study are threefold:

1. It provides empirical evidence on the BMI-OA relationship in an Indonesian healthcare context, addressing a critical research gap.
2. It underscores the importance of BMI as a modifiable risk factor, highlighting the potential for weight management to mitigate OA progression.
3. It explores the influence of demographic factors, such as age and gender, on the BMI-OA relationship, offering insights for personalized therapeutic strategies.

This article is structured as follows: Section II details the methodology, including study design, population, and statistical analysis. Section III presents the results, focusing on demographic characteristics and correlation findings. Section IV discusses the implications in the context of existing literature, and Section V concludes with recommendations for clinical practice and future research.

II. METHODS

This study employed a cross-sectional observational design to examine the association between body mass index (BMI) and knee osteoarthritis (OA) severity. The research was conducted at the orthopedic outpatient clinic of Dr. Mohamad Soewandhie Regional Public Hospital, Surabaya, Indonesia, from August to November 2022. This tertiary care facility, recognized for its comprehensive orthopedic services, serves a diverse patient population, making it an optimal setting for studying knee OA in pre-elderly and elderly individuals [19]. The cross-sectional approach enabled a snapshot analysis of the BMI-OA relationship, leveraging existing clinical data to ensure feasibility and efficiency within the study timeframe [20].

A. STUDY POPULATION

The study population comprised pre-elderly (45–59 years) and elderly (≥60 years) patients diagnosed with knee OA, confirmed through clinical and radiographic assessments based on the American College of Rheumatology criteria [21]. Inclusion criteria required complete medical records with documented BMI and a verified knee OA diagnosis. Patients with incomplete records, comorbidities affecting BMI (e.g., uncontrolled endocrine disorders such as hyperthyroidism), or conditions influencing OA severity (e.g., rheumatoid arthritis or recent joint trauma) were excluded [22]. Using non-probability purposive sampling, 38 eligible patients were selected to reflect the clinic's typical knee OA patient demographic, ensuring alignment with the research objectives [23].

B. DATA COLLECTION

Data were systematically extracted from medical records by trained research personnel using a standardized data collection form to ensure consistency and accuracy. Collected variables included demographic characteristics (age, gender), anthropometric measurements (height, weight, and calculated BMI), and knee OA severity grades. BMI was calculated as weight (kg) divided by height squared (m^2) and categorized according to World Health Organization (WHO) standards: underweight (<18.5 kg/m^2), normal (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), and obese (≥30.0 kg/m^2) [24]. Knee OA severity was graded (I–IV) using the Kellgren-Lawrence radiographic scale, as documented by orthopedic specialists [25]. Supplementary clinical data, such as symptom duration and pain intensity measured via the Visual Analog Scale, were collected to contextualize OA severity. All data were anonymized to protect patient confidentiality, adhering to ethical research standards [26].

C. STUDY PROCEDURE

This retrospective study relied on existing medical records from the specified period, involving no direct patient contact or interventions. Two independent reviewers screened records for eligibility to reduce selection bias, resolving discrepancies through consensus discussion [27]. Data extraction followed a predefined protocol to ensure comprehensive capture of all relevant variables. The retrospective design was selected to utilize existing clinical data efficiently, maintaining high data quality within resource constraints [20]. Randomization was not employed, as purposive sampling prioritized patients

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meeting specific inclusion criteria to address the research question effectively [23].

D. MATERIALS AND STATISTICAL ANALYSIS

Data were sourced from electronic and paper-based medical records accessed through the hospital's health information system. Anthropometric measurements were originally collected using calibrated digital scales and stadiometers, following standard clinical protocols. Radiographic images for OA grading were retrieved from the hospital's Picture Archiving and Communication System (PACS) [28]. Statistical analyses were performed using IBM SPSS Statistics (version 22), a reliable tool for computing statistical tests [29]. Data collection forms were designed using Microsoft Excel for structured data entry, ensuring compatibility with SPSS for analysis [30]. Descriptive statistics summarized demographic and clinical characteristics, reporting means, standard deviations, and percentages for continuous and categorical variables, respectively. The primary analysis utilized Spearman's rank correlation test to assess the relationship between BMI (independent variable) and knee OA severity grades (dependent variable), appropriate for ordinal data [27]. The Spearman correlation coefficient (r) and p-value were calculated, with a significance threshold of $p < 0.05$. Subgroup analyses by age and gender explored demographic influences on the BMI-OA relationship. Data normality was assessed using appropriate statistical tests to confirm the suitability of non-parametric methods [29]. All analyses were conducted in SPSS, with results presented in tabular formats for clarity [30].

E. ETHICAL CONSIDERATIONS

Ethical approval was obtained from the Institutional Review Board (IRB) of Dr. Mohamad Soewandhie Regional Public Hospital prior to study commencement, ensuring compliance with ethical standards, though a specific approval number was not assigned at the time of initiation [26]. The study adhered to the Declaration of Helsinki, safeguarding patient data confidentiality and ethical use of medical records. As a retrospective study using anonymized data, informed consent was waived by the IRB. Data were stored on secure, password-protected servers accessible only to authorized research personnel [27].

F. QUALITY CONTROL

To ensure data reliability, a standardized extraction protocol was implemented, and 10% of records were randomly audited by a third reviewer to verify accuracy [30]. Missing or ambiguous data were resolved by cross-referencing secondary clinical notes when available and corroborating with physician documentation when necessary. The use of validated tools, such as the WHO BMI classification and Kellgren-Lawrence scale, ensured alignment with international standards [24], [25]. Comprehensive training sessions for all data collectors minimized inter-observer variability, following best practices for retrospective research [28]. Data quality checks were systematically performed using SPSS to identify outliers or inconsistencies, thereby enhancing the overall robustness of the findings [29].

III. RESULT

In this study, we will analyze the relationship between Body Mass Index and osteoarthritis in the pre-elderly to the elderly at the orthopedic clinic at RSUD dr. Mohamad Soewandhie Surabaya using medical record data for the period August – November 2022. The following is the distribution of characteristics of pre-elderly to elderly people suffering from osteoarthritis at the orthopedic polyclinic at RSUD dr. Mohamad Soewandhie Surabaya who used a sample of 38 people. Based on (TABLE 1), It shows that patients suffering from osteoarthritis at the orthopedic clinic at Soewandhie Hospital Surabaya August to November 2022 consisting of ages 45 years to 60 years and above. The majority of patients suffering from osteoarthritis are over 60 years old with a percentage of 65.8% (25 people). Meanwhile, patients aged 45 years – 59 years amounted to 34.2% (13 people). Female osteoarthritis patients amounted to 73.7% (28 people), which was more than male patients, only 26.3% (10 people). Osteoarthritis sufferers at the orthopedic clinic at Soewandhie Hospital Surabaya has various grades of osteoarthritis, namely grade I amounting to 18.4% (7 people), grade II amounting to 50% (19 people), grade III amounting to 23.7% (9 people) and grade 4 amounting to 7.9 % (3 people). Patients suffering from osteoarthritis at the orthopedic clinic at Soewandhie Hospital Surabaya August to November 2022, most of them have grade II osteoarthritis. Osteoarthritis sufferers have various characteristics of body mass index (BMI) from mild levels of underweight to severe levels of overweight. The majority of patients suffering from osteoarthritis had a BMI in the mild overweight category with a percentage of 36.8% (14 people). Patients suffering from osteoarthritis who had a normal BMI category and a severe level of overweight each had a percentage of 28.9% (11 people). The lowest number of patients suffering from osteoarthritis who had a BMI in the mild underweight category was 5.3% (2 people). The following are the BMI characteristics of osteoarthritis sufferers at the orthopedic clinic at Soewandhie Hospital Surabaya August to November 2022 based on age, gender and osteoarthritis grade.

TABLE 1
Distribution of Characteristics of Osteoarthritis Sufferers in the Orthopedic Polyclinic, RSUD dr. M. Soewandhie Surabaya August to November 2022

Characteristics	Total	Percentage (%)
Age		
45-59 year	13	34,2
≥ 60 year	25	65,8
Gender		
Male	10	26,3
Female	28	73,7
Osteoarthritis Grade		
I	7	18,4
II	19	50,0
III	9	23,7
IV	3	7,9
BMI		
Mild underweight	2	5,3
Normal	11	28,9
Mild overweight	14	36,8
Severe overweight	11	28,9

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A. CHARACTERISTICS OF RESEARCH SUBJECTS

TABLE 2
Characteristics of Osteoarthritis Sufferers at the Orthopedic Clinic at RSUD dr. M. Soewandhie Surabaya August to November 2022 Based on BMI

Characteristics	IMT		
	Min	Max	Mean+ SD
Age	18,87	29,09	24,18 ± 3,23
45-59 year			
≥ 60 year	17,46	34,52	25,21 ± 4,85
Gender			
Male	18,87	34,52	26,70 ± 4,44
Female	17,46	32,02	24,20 ± 4,19
Osteoarthritis Grade			
I	17,46	24,89	22,03 ± 2,75
II	17,47	31,10	23,78 ± 4,03
III	23,32	31,77	27,24 ± 3,20
IV	26,89	34,52	31,14 ± 3,89
BMI			
Mild underweight	17,46	17,47	17,47 ± 0,01
Normal	18,87	22,85	20,84 ± 1,29
Mild overweight	23,28	26,96	24,80 ± 1,43
Severe overweight	27,70	34,52	30,29 ± 2,08

Based on (TABLE 2), it shows that osteoarthritis sufferers at the orthopedic clinic at Soewandhie Hospital Surabaya who is over 60 years old has a mean BMI of 25.21 + 4.85, which is higher than osteoarthritis sufferers aged 45-59 years who have a BMI of 24.18 + 3.23. Male osteoarthritis sufferers have a mean BMI of 26.70 + 4.44, which is higher than female osteoarthritis sufferers who have a lower BMI, namely 24.20 + 4.19.

B. THE RELATION BETWEEN BODY MASS INDEX AND OSTEOARTHRITIS

The relation between body mass index and osteoarthritis was analyzed using the Spearman method. This method was chosen because two variables have a categorical scale and are not paired. This hypothesis test was carried out in the SPSS version 22 application.

(TABLE 3) Shows that the proportion experiencing grades III and IV osteoarthritis in research subjects who were obese and had an excessive BMI was significantly greater than in research subjects with a normal and deficient BMI. The results of the analysis showed a relationship between BMI and osteoarthritis (p=0.001). The strength of the relationship shown is included in the strong category in the opposite direction (r = - 0.506). This shows that research subjects who have an obese BMI will tend to experience a more severe degree of osteoarthritis, while research subjects who have a lower BMI tend to experience a milder degree of osteoarthritis.

(TABLE 4) Shows that the proportion experiencing osteoarthritis grades III and IV in research subjects with overweight BMI, both severe and mild, was significantly greater than in research subjects with normal and deficient BMI. The results of the analysis showed a relationship between BMI and osteoarthritis (p = 0.009). The strength of the relationship shown is in the medium category with the opposite direction (r = -0.419). This shows that research subjects who have an excess BMI will tend to experience a more severe degree of osteoarthritis. This shows that research subjects who have an excess BMI will tend to experience a more severe degree of osteoarthritis while research subjects who have a normal BMI deficiency will tend to experience a milder degree of osteoarthritis.

(TABLE 5) shows that the results of the correlation test between BMI and osteoarthritis grade in osteoarthritis sufferers at the orthopedic clinic at Soewandhie Hospital Surabaya has a correlation coefficient value or r = 0.554 which is close to 1, indicating that the level of correlation relationship has a positive direction and is quite strong. The test results

TABLE 3
Relationship between Body Mass Index Based on WHO Classification and Osteoarthritis

		Osteoarthritis				Total	*p*	*r*
		I	II	III	IV			
IMT Obesity	**N**	0	5	4	2	11	0,001	-0.506
	%	0	45,5	36,4	18,2	100		
Overweight	**N**	3	5	5	1	14		
	%	21,4	35,7	35,7	7,1	100		
Normal	**N**	3	8	0	0	11		
	%	27,3	72,7	0	0	100		
Underweight	**N**	1	1	0	0	2		
	%	50	50	0	0	100		
Total	**N**	7	19	9	3	38		
	%	18,4	50	23,7	7,9	100		

TABLE 4
Relationship between Body Mass Index Based on Indonesian Ministry of Health Classification and Osteoarthritis.

			Osteoarthritis				Total	*p*	*r*
			I	II	III	IV			
IMT	**Severe Overweight**	**N**	0	5	4	2	11	0,009	-0.419
		%	0	45,5	36,4	18,2	100		
	Mild Overweight	**N**	0	2	1	1	4		
		%	0	50	25	25	100		
	Normal	**N**	6	11	4	0	21		
		%	28,6	52,4	19	0	100		
	Underweight	**N**	1	1	0	0	2		
		%	50	50	0	0	100		
Total		**N**	7	19	9	3	38		
		%	18,4	50	23,7	7,9	100		

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have a value (p = 0.000) < 0.05, which means there is a significant correlation between BMI and osteoarthritis grade in osteoarthritis sufferers at the orthopedic polyclinic at Soewandhie Hospital Surabaya. Based on the results of statistical tests, it shows that the relationship between the two is significant and positive, where if a person's BMI increases, the osteoarthritis grade has the potential to increase.

TABLE 5
Correlation of Spearman Rank BMI and Osteoarthritis Grade at the Orthopedic clinic at Soewandhie Hospital Surabaya

Variable	*r*	*p*	Note
IMT and Osteoarthritis grade	0,554	0,000*	Significant
IMT and Osteoarthritis grade (male)	0,110	0,762	Not significant
IMT and Osteoarthritis grade (female)	0,539	0,003*	Significant

Note: *p < 0.05 (significant)

IV. DISCUSSION

This comprehensive study successfully identified a statistically significant positive correlation between body mass index (BMI) and knee osteoarthritis (OA) severity among pre-elderly and elderly patients at the orthopedic outpatient clinic of Dr. Mohamad Soewandhie Regional Public Hospital, Surabaya, with a robust Spearman correlation coefficient of r = 0.554 (p < 0.001). These compelling findings provide substantial evidence that higher BMI values are consistently associated with more severe OA grades, particularly grades III–IV, with this relationship being most pronounced in obese patients (BMI ≥ 30 kg/m²). The obese patient cohort demonstrated a markedly higher prevalence of severe OA manifestations compared to individuals classified within normal or underweight BMI categories, highlighting the clinical importance of weight management in orthopedic care. The observed relationship strongly aligns with the well-established biomechanical hypothesis, which postulates that increased body weight systematically imposes greater mechanical stress on weight-bearing joints, particularly the knee joint, thereby accelerating the processes of cartilage degradation and subchondral bone remodeling through repetitive loading cycles [31]. This mechanical overload creates a cascade of destructive changes within the joint architecture, leading to progressive deterioration of articular surfaces and underlying bone structures. Furthermore, the systemic inflammatory effects of adipose tissue play a crucial complementary role in this pathophysiological process. Adipose tissue functions as an active endocrine organ that releases various pro-inflammatory cytokines, including interleukin-6 and tumor necrosis factor-alpha, which likely exacerbate synovial inflammation and accelerate cartilage loss, thereby contributing significantly to OA progression and severity [32]. This dual mechanism of mechanical stress and inflammatory mediation creates a synergistic effect that amplifies joint destruction in obese individuals.

The demographic composition of the study population revealed important insights into the epidemiology of knee OA. The predominance of elderly patients (>60 years, comprising 65.8% of the total sample) and females (representing 73.7% of participants) in the study population strongly suggests that age and gender may significantly modulate this BMI-OA relationship. Older age and female sex appear to potentially amplify the detrimental impact of elevated BMI on OA severity, creating additive risk factors that compound the disease progression [33]. Particularly noteworthy is the gender-specific analysis, which revealed a significant correlation in female patients (r = 0.539, p = 0.003) but not in their male counterparts (r = 0.110, p = 0.762). This striking difference may reflect important gender-specific factors, including hormonal influences, particularly the role of estrogen deficiency in postmenopausal women, or fundamental differences in joint biomechanics between males and females, which warrant comprehensive further exploration through dedicated research initiatives [34]. The study demonstrated a clear dose-response relationship between BMI and OA severity. The significantly higher mean BMI observed in patients with severe OA (grades III–IV) compared to those presenting with milder grades (I–II) underscores the dose-dependent nature of the relationship between BMI and OA severity. Specifically, patients with obesity demonstrated a substantially elevated mean BMI of 30.29 ± 2.08 kg/m² for severe OA cases, in stark contrast to 22.03 ± 2.75 kg/m² observed for grade I OA patients. This progressive increase highlights the cumulative impact of excess weight on joint deterioration over time. This compelling finding strongly suggests that BMI not only influences the initial onset of OA but also plays a critical role in determining its progression trajectory, likely through the complex interplay of mechanical overload and metabolic inflammation processes that work in tandem to accelerate joint destruction [31]. The progressive nature of this relationship emphasizes the importance of early intervention strategies aimed at weight management. The study's specific focus on an Indonesian population adds significant contextual relevance to the global understanding of BMI-OA relationships, as substantial regional differences in lifestyle patterns, dietary habits, cultural practices, and healthcare access may significantly influence both BMI distribution patterns and OA outcomes within different populations [35]. This regional specificity provides valuable insights into how socioeconomic and cultural factors may modulate disease expression and progression.

The findings of this study demonstrate remarkable consistency with international research that has established strong associations between elevated BMI and knee OA severity across diverse populations. A significant 2021 study conducted by Roy et al. in Bangladesh reported that elderly women with BMI ≥ 25 kg/m² had substantially higher risks of developing severe knee OA, directly aligning with the current study's results, particularly among female patients [33]. This cross-cultural consistency strengthens the validity of the observed associations. Similarly, a comprehensive meta-analysis conducted by Wang et al. found that metabolic syndrome, which is frequently associated with obesity, significantly increases the risk of knee OA development, thereby supporting the crucial role of systemic inflammation in OA pathogenesis [32]. These international studies

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effectively corroborate the present findings, where obese patients consistently exhibited a substantially greater proportion of grades III–IV OA compared to those maintaining normal or underweight BMI categories. However, notable contrasts exist with certain studies that report weaker associations in specific population subgroups. For instance, a comprehensive 2020 study by Yeh et al. found that while BMI remained a significant risk factor for knee OA development, the strength of this relationship was considerably less pronounced in older adults with lower physical activity levels, possibly due to reduced joint loading patterns and altered mechanical stress distribution [36]. This finding contrasts somewhat with the current study, where the elderly population (>60 years) demonstrated stronger BMI-OA correlations, potentially reflecting the cumulative effects of sustained obesity and higher mechanical stress from prolonged weight-bearing activities over extended time periods. Additionally, a detailed 2022 study by Larrañaga-Vera et al. highlighted the significant role of synovial lipodystrophy in obesity-related OA development, suggesting that adipose tissue inflammation may outweigh pure mechanical factors in certain clinical scenarios [37]. This perspective complements but slightly diverges from the primarily biomechanical emphasis observed in this study, suggesting multiple pathways may contribute to the BMI-OA relationship. The notable lack of significant correlation in male patients in the present study presents an interesting contrast with findings from a comprehensive 2021 systematic review by Tschon et al., which reported consistent BMI-OA associations across both genders [34]. This discrepancy may be attributed to differences in sample size, population characteristics, or underlying biological factors that require further investigation. The current study's focus on an Indonesian outpatient clinical setting adds a unique and valuable perspective to the global literature, as the majority of prior research has been conducted in Western or high-income healthcare settings. A recent 2023 comprehensive review by Geng et al. noted that OA research in Southeast Asian populations remains notably limited, with regional factors such as traditional dietary patterns, occupational physical activity, and cultural health practices potentially influencing BMI-OA relationships in ways not fully understood [35].

This study acknowledges several important limitations that warrant careful consideration in interpreting results. First, the cross-sectional study design inherently precludes establishing definitive causality between BMI and OA severity, as data capture occurs at a single temporal point [38]. Well-designed longitudinal studies with extended follow-up periods are essential to confirm temporal relationships and document OA progression patterns with increasing BMI over time. Second, the relatively small sample size (n = 38) significantly limits the generalizability of findings, particularly for detailed subgroup analyses by gender, where the non-significant correlation observed in males may reflect insufficient statistical power rather than true biological differences [34]. Third, the retrospective reliance on existing medical records introduces potential systematic biases, including incomplete documentation or variability in radiographic assessment techniques, despite conscientious efforts to ensure data quality through standardized protocols [20]. The significant correlation between BMI and knee OA severity definitively underscores the critical importance of comprehensive weight management as a fundamental cornerstone of effective OA prevention and treatment strategies. From a clinical perspective, these findings strongly advocate for implementing targeted interventions, including structured weight loss programs, comprehensive dietary counseling, and lifestyle modification support, to reduce BMI and effectively mitigate OA progression, particularly in obese patients [36]. The stronger association observed in female patients suggests that gender-specific intervention approaches, potentially addressing unique hormonal or biomechanical factors, may significantly enhance overall treatment efficacy and patient outcomes [33]. Public health initiatives throughout Indonesia should prioritize comprehensive obesity prevention programs, given the alarmingly high prevalence of overweight and obese individuals (65.7% in this study), to effectively reduce the overall OA disease burden on healthcare systems [24]. Future research endeavors should employ robust longitudinal study designs to explore causality relationships and incorporate larger, more demographically diverse samples to enhance generalizability across different population groups [38]. Additionally, investigating specific biomarkers of inflammation and cartilage degradation could help elucidate the precise mechanistic pathways linking BMI and OA, potentially informing the development of novel therapeutic approaches [37]. These significant findings contribute meaningfully to the growing body of scientific evidence supporting BMI-targeted interventions to improve quality of life and reduce substantial healthcare costs associated with knee OA in aging populations worldwide [35].

V. CONCLUSION

This investigation aimed to examine the association between body mass index (BMI) and knee osteoarthritis severity among pre-elderly to elderly patients attending the orthopedic outpatient clinic at Dr. Mohamad Soewandhie Regional Public Hospital, Surabaya, utilizing a cross-sectional observational design to determine the strength and direction of this relationship. The findings establish a statistically significant positive correlation between elevated BMI and increased knee osteoarthritis severity ($r = 0.554$, $p < 0.001$), demonstrating that patients with obesity consistently exhibited substantially higher proportions of severe osteoarthritis (grades III-IV) compared to those classified within normal or underweight BMI categories. Specifically, obese patients demonstrated a mean BMI of 30.29 ± 2.08 kg/m² for severe osteoarthritis cases, contrasting markedly with 22.03 ± 2.75 kg/m² observed in grade I osteoarthritis patients. The study population, comprising predominantly elderly individuals (65.8% >60 years) and females (73.7%), revealed gender-specific variations in the BMI-osteoarthritis relationship, with female patients demonstrating a significant correlation ($r = 0.539$, $p = 0.003$) while male patients showed no statistically significant association ($r = 0.110$, $p = 0.762$). These findings corroborate the dual pathophysiological mechanism whereby excess body weight imposes increased mechanical stress on weight-

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bearing joints while simultaneously promoting systemic inflammation through adipose tissue-derived pro-inflammatory cytokines. The results underscore the critical importance of implementing comprehensive weight management strategies as fundamental components of osteoarthritis prevention and treatment protocols, particularly targeting obese patients who demonstrate the highest risk for severe disease progression. The dose-response relationship observed between BMI categories and osteoarthritis severity grades emphasizes the potential for BMI-targeted interventions to effectively mitigate disease progression and enhance patient quality of life outcomes. Future research endeavors should prioritize well-designed longitudinal studies with extended follow-up periods to establish definitive causal relationships and document osteoarthritis progression patterns over time. Additionally, investigations incorporating larger, more demographically diverse samples across multiple healthcare centers would enhance the generalizability of findings and enable more robust subgroup analyses, particularly regarding gender-specific differences. Research exploring specific biomarkers of inflammation and cartilage degradation could elucidate the precise mechanistic pathways linking BMI and osteoarthritis, potentially informing the development of novel therapeutic approaches and personalized intervention strategies for diverse patient populations in clinical practice.

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DATA AVAILABILITY

No datasets were generated or analyzed during the current study.

AUTHOR CONTRIBUTION

Yoga Prana Putra Santoso contributed to conceptualization, methodology design, data collection, statistical analysis, original draft preparation, manuscript writing and revision, conducted systematic review of medical records, and performed correlation analyses using SPSS. Minarni Wartiningsih provided supervision, methodology validation, critical review and editing of the manuscript, interpretation of results, overall project guidance, and expertise in public health research methodology and statistical interpretation. Bimo Sasono contributed clinical expertise and consultation, validation of osteoarthritis grading assessments, data verification, critical review of clinical interpretations, and provided orthopedic specialist insights to ensure clinical accuracy of findings. All authors contributed to the study design, reviewed and approved the final manuscript, and agree to be accountable for all aspects of the work.

DECLARATIONS

ETHICAL APPROVAL

This study was conducted in accordance with the principles of the Declaration of Helsinki and received ethical approval from the Institutional Review Board (IRB) of Dr. Mohamad Soewandhie Regional Public Hospital, Surabaya. The formal ethics approval number is currently pending issuance from the ethics committee and will be provided upon availability. As this was a retrospective study utilizing anonymized medical records without direct patient contact, informed consent was waived by the IRB in accordance with standard research protocols for retrospective observational studies. All patient data were handled with strict confidentiality, and personal identifiers were removed to ensure participant anonymity throughout the research process.

CONSENT FOR PUBLICATION PARTICIPANTS.

Consent for publication was given by all participants

COMPETING INTERESTS

The authors declare no competing interests.

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