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Knee Osteoarthritis and Obesity: Correlation of Body Mass Index with Radiographic Severity and Functional Disability

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Abstract: ***Background:*** Knee osteoarthritis (KOA) is a leading cause of chronic pain, disability, and poor quality of life in individuals worldwide, making it a major public health concern. It is distinguished by the slow degeneration of articular cartilage, the remodeling of subchondral bone, the formation of osteophytes, and varying levels of synovial inflammation. ***Aim:*** This study aims to contribute to the growing evidence base on the role of obesity in knee osteoarthritis and to inform preventive and therapeutic strategies relevant to both Indian and global populations. ***Materials and Methods:*** A "cross-sectional observational study was conducted in a hospital setting, involving 120 individuals aged 40 years and older who had been clinically and radiographically diagnosed with knee osteoarthritis (KOA)... The World Health Organization's standards were used to determine and classify body mass index (BMI). The radiographic severity of weight-bearing knee radiographs was assessed using the Kellgren–Lawrence (KL) grading system. Functional impairment was evaluated using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). The Chi-square test was employed to investigate the relationships between BMI categories and KL grades, while Pearson's correlation coefficient was employed to assess the connections between BMI and WOMAC scores. ***Results:*** The cohort was "61.7% female, with a mean age of 58.6 ± 8.9 years. 85.0% of participants were obese or overweight. Obese patients exhibited a higher prevalence of advanced KOA (KL grades 3 and 4), and radiographic severity increased considerably with increasing BMI ($\chi^2 = 32.84$, $p < 0.001$). The WOMAC pain ($r = 0.58$), rigidity ($r = 0.49$), physical function ($r = 0.62$), and total scores ($r = 0.65$) exhibit a significant positive correlation with BMI (all $p < 0.001$)". ***Conclusion:*** Higher BMI is significantly associated with greater radiographic severity and functional disability in knee osteoarthritis. These findings underscore the importance of weight management strategies in the prevention and clinical management of KOA.

Keywords: Knee osteoarthritis; Obesity; Body mass index; Radiographic severity; Functional disability; WOMAC index

INTRODUCTION

As a major public health issue, knee osteoarthritis (KOA) is responsible for a great deal of suffering across the world, including long-term pain, disability, and diminished quality of life. Articular cartilage degeneration, subchondral bone remodeling, osteophyte formation, and varying degrees of synovial inflammation are hallmarks of this condition. The increasing prevalence of obesity and an ageing population have largely contributed to the steady rise in the incidence of KOA during the past few decades [1,2]. The bulk of the years lived with disability due to osteoarthritis are attributable to knee involvement, according to the Global Burden of Disease research [15].

It is now widely recognized that obesity is a major modifiable risk factor for the onset and advancement of KOA. Mechanical stress on the knee joint accelerates cartilage wear and joint degeneration when a person is overweight, particularly while engaging in activities such as walking, stair climbing,

and squatting [8]. The association between obesity and KOA, however, extends beyond biomechanical stress, according to new studies. One of the endocrine organs that plays a role in low-grade systemic inflammation, cartilage disintegration, and pain sensitization is adipose tissue, which generates adipokines and pro-inflammatory mediators [6,9]. We now see KOA as a complex disease influenced by systemic factors, rather than a simple "wear-and-tear" sickness, thanks to this combination mechanical-metabolic approach.

In both clinical and epidemiological studies, body mass index (BMI) is commonly utilized as a proxy measure for obesity. An increased risk of incident KOA, quicker radiographic development, and greater symptom intensity have all been associated with a higher body mass index (BMI), according to many studies [1,2,7]. The Kellgren-Lawrence (KL) grading system is used to determine the radiographic severity of KOA. On the other hand, patient-reported outcome measures like the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) are often used to determine clinical severity and functional impairment. While the strength of the relationships varies by demographic, prior research has linked obesity to lower WOMAC scores and higher KL grades [3,6,10].

Due to rapid urbanization, changes in lifestyle, and a worrying increase in the prevalence of overweight and obesity across all age categories, the impact of KOA is especially worrisome in low- and middle-income nations such as India [3,4]. Researchers in India found that those with a higher body mass index (BMI) tend to show up sicker and younger, with greater mobility issues, functional restrictions, and severe disease symptoms [3,4]. Regardless, few studies have directly compared Indian clinical settings to international literature on the combined relationship of body mass index (BMI), radiographic severity, and functional impairment.

Furthermore, discordance between radiographic findings and clinical symptoms is well recognized in KOA, underscoring the importance of evaluating both structural and functional outcomes when assessing disease severity [13]. Understanding how BMI relates simultaneously to radiographic damage and patient-reported disability is therefore crucial for informing comprehensive management strategies. Weight reduction has been shown to improve pain and function and reduce joint loading, highlighting obesity as a key therapeutic target in KOA management [11,12].

Against this background, the present study was undertaken to evaluate the correlation between BMI and radiographic severity of KOA, as assessed by Kellgren–Lawrence grading (KL), and functional disability measured using the WOMAC index. By examining both structural and clinical dimensions of disease severity, this study aims to contribute to the growing evidence base on the role of obesity in knee osteoarthritis and to inform preventive and therapeutic strategies relevant to both Indian and global populations .

Materials & methods:

A cross-sectional observational study was conducted at the Department of Orthopedics at a tertiary care teaching hospital in India during an 18-month duration. The research sought to ascertain the correlation between body mass index (BMI), radiographic severity, and functional impairment in patients with knee osteoarthritis (KOA). One hundred twenty adult patients with clinically and radiographically confirmed knee osteoarthritis were progressively recruited from the outpatient orthopedic clinic. The research enrolled individuals aged 40 years or older, irrespective of gender, who experienced knee discomfort for a minimum of six months and satisfied the clinical criteria for knee osteoarthritis as established by the American College of Rheumatology.

Inclusion Criteria

- Adults aged ≥40 years
- Clinical diagnosis of primary knee osteoarthritis
- Radiographic evidence of KOA on plain X-ray
- Ability to ambulate independently
- Willingness to provide informed consent

Exclusion Criteria

- Secondary osteoarthritis due to trauma, inflammatory arthritis, infection, or congenital deformities
- History of knee surgery or intra-articular injections in the preceding 6 months
- Neuromuscular disorders affecting gait
- Severe systemic illness or malignancy
- Pregnant women

Ethical Considerations

After reviewing the research procedure, the Institutional Ethics Committee gave its approval. Before being registered, every single person gave their written informed consent. The study maintained the utmost secretiveness for all patients .

Anthropometric Assessment

While respondents stood tall and barefoot, a calibrated digital weighing scale recorded their weight to the nearest 0.1 kg, and a stadiometer recorded their height to the nearest 0.1 cm. BMI was calculated by dividing the weight in kilograms by the square of the height in meters (kg/m^2).

Participants were categorized according to World

Health Organization BMI classification:

- Normal weight: 18.5–24.9 kg/m²
- Overweight: 25.0–29.9 kg/m²
- Obese: ≥30.0 kg/m²

Standard anteroposterior weight-bearing radiographs of both knees were obtained for all participants. Radiographic severity of osteoarthritis was graded using the Kellgren–Lawrence (KL) grading system, ranging from grade 1 (doubtful OA) to grade 4 (severe OA). In patients with bilateral involvement, the knee with the higher KL grade was considered for analysis. Radiographs were independently evaluated by two experienced orthopaedic surgeons blinded to the clinical and anthropometric data, and discrepancies were resolved by consensus.

Assessment of Functional Disability

Functional status and symptom severity were assessed using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) questionnaire. There are 24 items total on the WOMAC index, with 5 measuring pain, 2 measuring stiffness, and 17 measuring physical function. Higher WOMAC scores indicate increased pain, stiffness, and functional impairment; each item was evaluated on a Likert scale. The subscale values were added together to give the overall score.

Information on the participants' age, gender, the length of time they had knee pain, and whether the pain was on one side or both sides was recorded using a systematic proforma. We performed the radiographic and clinical exams on the same day to reduce variability.

Statistical analysis:

Data was entered and analyzed using Statistical Package for the Social Sciences (SPSS) version XX. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. The association between BMI categories and radiographic severity (KL grades) was analyzed using the Chi-square test. Correlation between BMI and WOMAC scores (pain, stiffness, physical function, and total score) was assessed using Pearson's correlation coefficient. A p-value of <0.05 was considered statistically significant.

RESULTS

Table 1. Demographic and Clinical Characteristics of the Study Population (n = 120)

Variable	Mean ± SD / n (%)
Age (years)	58.6 ± 8.9
Male	46 (38.3%)
Female	74 (61.7%)
BMI (kg/m²)	29.4 ± 4.6
Normal weight	18 (15.0%)
Overweight	52 (43.3%)
Obese	50 (41.7%)
Duration of Knee Pain (years)	5.2 ± 2.7
Unilateral involvement	34 (28.3%)
Bilateral involvement	86 (71.7%)
Mean WOMAC Total Score	54.8 ± 15.6

Table 2. Association Between BMI and Radiographic Severity (Kellgren–Lawrence Grade)

BMI Category	KL Grade 1	KL Grade 2	KL Grade 3	KL Grade 4	Total
Normal weight	6	8	4	0	18
Overweight	4	18	20	10	52
Obese	1	8	18	23	50

Chi-square test = 32.84, $p < 0.001$

Table 3. Correlation of BMI with WOMAC Functional Disability Scores

Variable	Pearson r	p-value
BMI vs WOMAC Pain Score	0.58	<0.001
BMI vs WOMAC Stiffness Score	0.49	<0.001
BMI vs WOMAC Physical Function Score	0.62	<0.001
BMI vs WOMAC Total Score	0.65	<0.001

The study included 120 individuals with knee osteoarthritis (mean age: 58.6 ± 8.9 years). Males comprised 38.3% of the study population, while females comprised 61.7%. The high prevalence of overweight and obesity is indicated by the average BMI of 29.4 ± 4.6 kg/m². 43.3% of individuals were classified as overweight, 41.7% as obese, and only 15.0% as having a healthy BMI, as per BMI categorization. The average duration of knee discomfort was 5.2 ± 2.7 years. A bilateral knee involvement was observed in 71.7% of patients, while 28.3% of patients had unilateral knee involvement. The study participants' average WOMAC total score was 54.8 ± 15.6, which connotes moderate to severe functional impairment.

Table 2 illustrates a statistically significant correlation ($\chi^2 = 32.84$; $p < 0.001$) between the radiographic severity of knee osteoarthritis as indicated by the Kellgren-Lawrence grading system and BMI categories. Mild to severe radiographic alterations were observed in patients with a normal body mass index (BMI), with 77.7% of them falling into KL categories 1 and 2. In contrast, individuals who were overweight exhibited a higher incidence of moderate to severe osteoarthritis, with 57.7% of cases falling into KL categories 3 and 4. Obese individuals were the most likely to exhibit advanced radiographic disease, with 82.0% displaying KL grades 3 and 4, and nearly half (46.0%) presenting with KL grade 4 alterations. These data indicate a consistent rise in radiographic severity as BMI increases.

Table 3 demonstrated a significant positive correlation between body mass index and all components of the WOMAC score. There was a moderate-to-strong correlation between BMI and WOMAC pain ($r = 0.58$, $p < 0.001$), rigidity ($r = 0.49$, $p < 0.001$), and physical function scores ($r = 0.62$, $p < 0.001$). The WOMAC total score was most significantly correlated with BMI ($r = 0.65$, $p < 0.001$), indicating that individuals with knee osteoarthritis experience more overall functional impairment as their BMI increases.

DISCUSSION

Researchers set out to determine whether there was a correlation between functional impairment, radiographic severity, and BMI in KOA patients. Higher WOMAC ratings indicated a more severe degree of pain, stiffness, and functional impairment. Additionally, the study discovered a robust correlation between a higher body mass index and a lower radiography grade. A growing body of evidence suggests that obesity is a major risk factor that may be altered to improve the structural and clinical manifestations of KOA. This data provides more support for the theory.

Nearly eighty-five percent of those "who took part in the study were overweight or obese, and there was a statistically significant correlation between being overweight and having a higher risk of serious disease (KL grades 3 and 4). Radiographic severity is inversely related to body mass index (BMI), according to a large body of research spanning both population and hospital settings throughout the globe. Severe radiographic KOA was associated with a higher body mass index (BMI). This indicates that the effect of obesity on joint degeneration is weight dependent [1]. Overweight people are more likely to develop osteoarthritis of the knee, according to a meta-analysis [2].

Similar results have been found in studies. Obesity may hasten the deterioration of weight-bearing joints in the Indian population, according to this study. Those with a higher BMI had more severe KL grades and symptoms started sooner, more quickly. Among middle-aged and older women, a multicentric study found that the frequency of KOA increases in tandem with the prevalence of obesity [4]. The female preponderance may be explained by hormonal impacts, altered biomechanics, and variations in fat distribution, which aligns with another research done in India and beyond [5].

Subjects' WOMAC pain, stiffness, physical function, and total ratings (not including radiographic severity) were positively associated with their body mass index (BMI) in the present study. A higher body mass index (BMI) was associated with worse overall functional impairment, according to a strong correlation between the two variables ($r = 0.65$). These results are consistent with a previous study that shown, independent of radiographic severity, that fat substantially impacts the experience of pain and physical limits [6]. Similarly, cross-sectional research shown that body mass index (BMI) was more strongly correlated with WOMAC functional impairment than with radiographic changes, highlighting the therapeutic value of obesity in symptom burden". [7].

The severity of KOA is associated with weight for numerous reasons. When a person is overweight, their tibiofemoral joint experiences increased stress, which accelerates cartilage degeneration and subchondral bone remodelling [8]. In addition, adipose tissue has a role as an endocrine organ, secreting adipokines such as leptin, resistin, and adiponectin. These adipokines promote low-grade systemic inflammation and the degradation of cartilage [9]. Obesity is linked to structural deterioration, increased discomfort, and functional impairment, as revealed by this combined mechanical-metabolic pathway.

The correlation between pain and physical performance "was stronger than that between body mass index and WOMAC stiffness. Consistent findings suggest that factors other than body mass index could influence rigidity [10]. Illness of synovium and lack of muscular strength are two of these causes. Weight loss is crucial for KOA patients to enhance their quality of life since there is a high correlation between body mass index and WOMAC total scores.

There has always been a correlation between weight loss and better clinical outcomes in KOA. According to research by Messier et al. [11], reducing body fat by as low as 5–10% significantly improved pain levels, physical function, and joint stress. Lifestyle modification activities may reduce sickness burden

without relying on costly drugs, making these findings relevant to Indian contexts [12].

It is important to remember a few points regarding this study. The cross-sectional nature of the study precludes drawing any firm conclusions on a correlation between BMI and severity of illness. Furthermore, sarcopenic obesity and the distribution of fat throughout the body were disregarded when body mass index (BMI) was used as the only measure of adiposity". Also, as can be shown on MRI, radiographic evaluations using the Kellgren-Lawrence grading system missed the early changes in soft tissue or cartilage. In addition, we did not include things like psychological variables, metabolic comorbidities, occupational stress, or levels of physical exercise. Finally, the study's location in a hospital limits the results' applicability to the wider public.

Longitudinal studies should be the focus of future research if we want to better understand the links between obesity and KOA. To get to the bottom of things, we may look for inflammatory biomarkers, evaluate body composition, and use cutting-edge imaging methods. Particularly for those of Indian descent, further interventional trials examining regimens of organized exercise and weight loss are required. In order to slow the increasing prevalence of knee osteoarthritis, public health initiatives aimed at reducing obesity would be highly effective.

Conclusion:

This study demonstrates a significant positive association between body mass index and both radiographic severity and functional disability in patients with knee osteoarthritis. Higher BMI was consistently linked with advanced Kellgren–Lawrence grades and elevated WOMAC scores, indicating greater pain, stiffness, and impairment in physical function. These findings support the dual mechanical and metabolic role of obesity in accelerating osteoarthritic changes. Given the rising prevalence of obesity, targeted weight-management and lifestyle-based interventions should be integral to osteoarthritis management strategies to reduce disease progression and improve patient-reported outcomes.

Conflict of interest:

None.

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