

## Clinical and Radiological Evaluation of Knee Osteoarthritis and Its Association with Body Mass Index

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### Abstract

**Background:** Pain and disability from knee osteoarthritis is a major problem, and excess body weight is a significant modifiable risk factor. Body mass index (BMI), clinical symptoms and radiographic severity are important for early intervention.

**Methods:** A cross sectional study of 220 adults with symptomatic knee osteoarthritis. The clinical severity was evaluated by pain visual analogue scale (VAS) and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). The Kellgren-Lawrence (KL) system was used to grade weight-bearing anteroposterior and lateral knee radiographs. BMI was classified as normal, overweight, obese class I and obese class II or higher.

**Results:** Mean age was 58.9 +/- 8.7 years; 128 patients (58.2%) were female. Mean BMI was 28.7 +/- 4.6 kg/m<sup>2</sup>. 94 patients (42.7%) had KL grade III-IV disease. There was a significant correlation between BMI and VAS, WOMAC and KL grade (p<0.001). The mean WOMAC score was 61.8 +/- 13.4 in patients with a BMI of class II or higher, and 38.6 +/- 12.1 in normal BMI patients. BMI correlated positively with KL grade (r=0.46), VAS (r=0.41), and WOMAC (r=0.49; all p<0.001).

**Conclusion:** Increased BMI was significantly associated with worse clinical and radiological knee osteoarthritis. Weight management should be a key part of osteoarthritis treatment.

**Keywords:** knee osteoarthritis, BMI, Kellgren-Lawrence grade, WOMAC, radiology, obesity.

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### Introduction

Knee OA is a leading cause of pain, stiffness, loss of mobility and disability in older people and one of the most prevalent chronic musculoskeletal conditions. The disease is characterized by progressive loss of articular cartilage, subchondral bone remodelling, osteophyte formation, synovial inflammation and periarticular muscle dysfunction. Clinical symptoms may wax and wane and radiographic changes can occur over years [1].

BMI is a well-known risk factor for knee OA development and progression. Overweight leads to mechanical stress on the tibiofemoral and patellofemoral joints, higher peak knee adduction moments, and higher cartilage stress. Furthermore, adipose tissue is metabolically active and produces

inflammatory adipokines which can lead to low-grade joint inflammation [2]. Meta-analyses have revealed that there is a significant increase in the risk of knee OA with higher BMI, both clinically, radiographically and surgically [3]. The relationship of BMI to symptom severity and radiological grade in specific hospital populations, however, may be different and dependent on age, sex, occupation, alignment, physical activity, and pain sensitivity.

Pain scores and functional indices (WOMAC) are commonly used in clinical assessment, while radiological severity is often graded with the Kellgren-Lawrence system. There is often a discrepancy between symptoms and radiographs:

some patients have advanced radiographic disease, but only mild symptoms, and others have mild symptoms and advanced radiographic disease. Knowing the relationship between BMI and both areas could help to better prioritize counselling and treatment. [4]

Weight loss is advised in most guidelines for the management of osteoarthritis as any amount of weight loss can help to decrease the load on the knees and alleviate symptoms. Nevertheless, many patients consider osteoarthritis to be a part of the aging process and do not value the therapeutic importance of weight loss, strengthening exercises, and lifestyle modification [5].

The purpose of this study was to determine the clinical and radiological severity of knee OA and its relationship with BMI. The goals were to compare pain, WOMAC score, and KL grade within BMI categories and to measure the correlation between BMI and severity of the OA measures.

### Materials and Methods

The present study is a cross sectional study conducted in orthopaedics OPD of tertiary care teaching hospital. A total of 220 adults aged 40 years and above with symptomatic primary knee osteoarthritis were enrolled. Diagnosis was made based on clinical features and radiography.

Patients were excluded if they had inflammatory arthritis, post-traumatic arthritis, previous knee surgery, recent intra-articular injection, acute

ligament injury, severe hip or spine disease affecting gait, or secondary osteoarthritis due to infection or metabolic bone disease. Demographic data, occupation, duration of symptoms, comorbidities and use of analgesics were documented. Standardized equipment was used to measure height and weight, and BMI was calculated as kg/m<sup>2</sup>. BMI categories were normal (<25), overweight (25-29.9), obese class I (30-34.9), and obese class II or higher (>=35). A visual analogue scale was used to measure pain. Function was assessed using WOMAC total score. Anteroposterior and lateral radiographs of the affected knee were taken. If both knees were painful, the more painful knee was analysed. Two observers independently used the Kellgren-Lawrence classification to grade the radiographs.

The data were analysed using SPSS version 26. The continuous variables were presented as mean  $\pm$  SD. The clinical scores were compared using ANOVA across BMI categories and association between BMI category and KL grade was assessed using chi-square test. Pearson/Spearman correlation coefficients were computed where appropriate with  $p < 0.05$  being considered statistically significant.

### Results

The study dataset was checked for completeness before analysis. All enrolled participants had complete clinical records and laboratory or imaging values required for the primary outcomes. Descriptive and inferential results are presented in the following tables.

**Table 1. Baseline profile of patients with knee osteoarthritis (n=220).**

| Variable           | Category/Measure | Value                          |
|--------------------|------------------|--------------------------------|
| Age                | Mean +/- SD      | 58.9 +/- 8.7 years             |
| Sex                | Male             | 92 (41.8%)                     |
| Sex                | Female           | 128 (58.2%)                    |
| BMI                | Mean +/- SD      | 28.7 +/- 4.6 kg/m <sup>2</sup> |
| Symptom duration   | Median (IQR)     | 24 (12-48) months              |
| Bilateral symptoms | Yes              | 136 (61.8%)                    |
| Mean VAS           | 0-10 scale       | 6.2 +/- 1.7                    |
| Mean WOMAC         | 0-96 scale       | 51.4 +/- 15.6                  |

Table 1 shows that the cohort was predominantly female, with mean BMI in the overweight range and frequent bilateral knee symptoms.

**Table 2. Clinical and radiological severity across BMI categories.**

| BMI category             | n (%)      | VAS score   | WOMAC score   | KL grade III-IV | p-value |
|--------------------------|------------|-------------|---------------|-----------------|---------|
| Normal                   | 38 (17.3%) | 4.9 +/- 1.5 | 38.6 +/- 12.1 | 9 (23.7%)       | <0.001  |
| Overweight               | 82 (37.3%) | 5.8 +/- 1.4 | 47.8 +/- 13.6 | 27 (32.9%)      |         |
| Obese class I            | 70 (31.8%) | 6.7 +/- 1.5 | 56.3 +/- 13.9 | 37 (52.9%)      |         |
| Obese class II or higher | 30 (13.6%) | 7.3 +/- 1.4 | 61.8 +/- 13.4 | 21 (70.0%)      |         |

Table 2 demonstrates a stepwise increase in pain, disability, and advanced radiographic grade across BMI categories.

**Table 3. Correlation between BMI and osteoarthritis severity measures.**

| Severity measure        | Correlation coefficient | p-value |
|-------------------------|-------------------------|---------|
| VAS pain score          | r=0.41                  | <0.001  |
| WOMAC total score       | r=0.49                  | <0.001  |
| Kellgren-Lawrence grade | rho=0.46                | <0.001  |
| Symptom duration        | r=0.18                  | 0.008   |
| Age                     | r=0.11                  | 0.10    |

Table 3 shows significant positive correlations between BMI and clinical as well as radiographic osteoarthritis severity.

On multivariable analysis adjusted for age, sex, symptom duration, and occupation, BMI remained an independent predictor of WOMAC score (beta=0.42, p<0.001) and KL grade III-IV disease (adjusted OR=1.18 per kg/m<sup>2</sup> increase, 95% CI: 1.09-1.28; p<0.001). Female sex was associated with higher WOMAC score but not independently with KL grade after BMI adjustment.

### Discussion

The study showed that there was a strong relationship between increased BMI and poor clinical and radiological knee OA. Patients in obese categories had higher prevalence of KL grade III-IV disease, higher WOMAC scores and higher pain. The results are in line with the known mechanical and metabolic effects of obesity on knee OA [2,3].

The mechanical explanation is simple: cumulative loading on the knee during walking, stair climbing, squatting and rising from a chair increases with each kg of body weight. Repetitive excess load causes cartilage wear and subchondral bone stress. Malalignment can also increase the forces, especially in the medial compartment [4].

Systemic inflammation is another way that obesity can contribute to the development of OA. Cartilage catabolism and synovial activation may be affected by adipokines, cytokines, insulin resistance, and low-grade metabolic inflammation. This may account for some of the associations of obesity with hand osteoarthritis in some studies [5] as well as with weight-bearing joint disease.

The correlation between BMI and WOMAC was greater than the correlation between BMI and KL grade. This implies that body mass has an effect on pain and function that is independent of radiographic joint space narrowing, such as muscle weakness, activity tolerance, low grade inflammation, and psychosocial factors. [6]

The clinical-radiological discordance is still significant. Some patients with normal BMI had advanced radiographic disease and some obese patients had moderate radiographic changes and severe symptoms. Treatment should thus be based on pain, function, radiographs, alignment, patient expectations, and comorbidities, not just KL grade.

The results validate early weight management counselling as an integral part of the treatment of osteoarthritis. Some weight loss, along with strengthening the quadriceps and doing low impact aerobic exercise can help to decrease pain and improve function. Preoperative weight optimization may decrease the risk of surgery and increase the potential for rehabilitation for obese patients who are undergoing arthroplasty. [7]

The limitations include cross-sectional design, single centre recruitment and BMI not being used as body composition or waist circumference. The objective measurement of alignment and muscle strength was not performed. Longitudinal studies are required to establish if BMI reduction in this population is associated with slowing of radiographic progression and reduced need for surgery.

The progressive increase in WOMAC and KL grade with increasing BMI has implications for outpatient counselling. Patients may think of osteoarthritis as cartilage wear, but may not realize that the cumulative load of body weight on daily activities may be the cause of the wear. Information on knee joint forces during walking and stair climbing (which are multiples of body weight) can help to make weight reduction advice more meaningful. [8]

BMI was correlated with symptoms and radiographic severity, but should not be considered as a single factor. Other factors that affect disease expression include muscle strength, varus alignment, occupational kneeling, sitting on the floor, previous injury, and metabolic health. Weight loss and strengthening of the quadriceps, flexibility exercises, and recommendations for footwear, rationalization of analgesics and treatment of comorbidities should be integrated into a patient-centred plan.

BMI was more strongly correlated with WOMAC than with age, which implies that lifestyle factors are more significant than chronological ageing in many patients. This is a positive development as weight loss and exercise can begin at any stage of the radiographic disease, even prior to the development of advanced deformity. [9]

Radiological grading is still useful for the staging of the disease and surgical referral, but should be used in conjunction with symptoms and functional limitation. Conservative treatment can be very

beneficial for patients with high BMI and moderate radiographic disease, while patients with advanced KL grade, deformity, night pain and severe disability may benefit from arthroplasty evaluation after risk optimization.[10] The predominance of females in this cohort is similar to many studies on osteoarthritis and may be associated with hormonal changes after menopause, body composition, occupational factors and health-seeking behaviour. BMI was still a strong predictor after adjustment, however, indicating that excess body mass is relevant in both males and females.

The distribution of the radiographs revealed that the higher the BMI, the more advanced the KL grades. This could be because obese patients have an earlier onset and more rapid progression. Early detection of high-BMI patients at KL grade I or II may provide an opportunity for preventing progression to deformity and surgical dependency. Conservative treatment should be planned and not just restricted to analgesics. Adherence may be enhanced through education, supervised exercises, home-based strengthening, weight-loss goals, walking aids as necessary, and regular reassessment. Intra-articular injections may temporarily relieve symptoms, but should not be used as a substitute for mechanical load reduction.

Researchers consider BMI to be a very simple indicator and cannot distinguish fat mass from lean mass. Further research with waist circumference, body fat percentage, gait analysis, limb alignment and inflammatory markers could help to better understand the relative mechanical and metabolic role of obesity in knee OA.

BMI was associated with an increase in pain severity, while sleep, mood, central sensitization and activity avoidance were associated with pain perception. In obese patients, pain can lead to decreased movement, which leads to weight gain, which leads to increased knee load, and so on. To break this cycle, you need to set realistic, incremental targets, instead of giving short-term advice on weight loss.

X-rays were taken in weight bearing position as non-weight bearing films may underestimate joint space narrowing. This methodological aspect is significant for routine practice: the accurate radiological grading depends on the correct positioning, exposure and comparison with the most symptomatic clinical knee. [11-15]

There is also an association between BMI and advanced KL grade which has implications for arthroplasty planning. While high BMI may be associated with greater risk during surgery, postponing surgery without providing a structured weight and strengthening support program may lead to longer periods of disability. Shared decision

making should take into account the severity of symptoms, radiographic damage, optimization of the patient's comorbidity, and patient goals. The study also helps in early detection of overweight patients before they become obese. Early intervention at the overweight stage may help to avoid progression to advanced radiographic disease and disability. BMI should be recorded on all visits to the clinician for an individual with OA and should be considered as a key part of the disease assessment rather than an unrelated comorbidity.

Diet counselling and physiotherapy in health systems may be more effective than episodic prescriptions of analgesics in the management of osteoarthritis. Evidence of BMI can be translated into tangible clinical improvement through group education, easy home exercise charts, regular weight monitoring, and referral systems for high-risk obese patients. [16]

This multi-disciplinary approach is particularly relevant in communities where squatting, using the stairs and floor level activities are still a way of life and impose a significant functional demand on painful knees. Early lifestyle intervention can maintain independence and avoid expensive surgical interventions.

## Conclusion

Higher BMI was significantly correlated with higher pain, functional disability, and radiographic severity in knee OA. BMI was an independent predictor even after adjusting for age and sex. Emphasis should be placed on weight control, exercise and lifestyle modification as early as possible in the management of knee osteoarthritis.

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