Section: Orthopedics

Original Research Article

PREVALENCE AND SEVERITY OF KNEE OSTEOARTHRITIS BASED ON KELLGREN-LAWRENCE GRADING AND ITS CORRELATION WITH BODY MASS INDEX AND OCCUPATIONAL PROFILE IN PATIENTS PRESENTING FOR ARTHROPLASTY WORKUP: A CROSS-SECTIONAL STUDY

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Received : 12/04/2026
Received in revised form : 02/06/2026
Accepted : 17/06/2026

Keywords:
Knee osteoarthritis, Kellgren–Lawrence grading, Body mass index, Occupational profile, Total knee arthroplasty.

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DOI: 10.47009/jamp.2026.8.3.283

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2026; 8 (3); 1615-1620

ABSTRACT

Background: Knee osteoarthritis (KOA) is one of the leading causes of pain, functional disability, and reduced quality of life among the elderly population worldwide. Radiographic assessment using the Kellgren–Lawrence (K–L) grading system remains the standard method for evaluating disease severity and guiding treatment decisions, including total knee arthroplasty (TKA). Obesity and occupational mechanical loading are recognized risk factors for KOA; however, data regarding their association with radiographic severity among patients presenting for arthroplasty workup remain limited. This study aimed to determine the distribution of radiographic severity of KOA based on the K–L grading system and evaluate its association with body mass index (BMI) and occupational profile. **Materials and Methods:** A hospital-based cross-sectional observational study was conducted among 200 consecutive adult patients with primary knee osteoarthritis presenting for total knee arthroplasty evaluation at a tertiary care center. Demographic details, anthropometric measurements, and occupational profiles were recorded using a structured proforma. BMI was calculated and categorized according to the World Health Organization classification. Standard weight-bearing knee radiographs were graded using the Kellgren–Lawrence classification (Grades I–IV). Associations between K–L grade and BMI categories, as well as occupational profile, were analyzed using the Chi-square test, while ordinal logistic regression was performed to identify independent predictors of increasing radiographic severity. A p-value <0.05 was considered statistically significant. **Results:** The mean age of participants was 64.8 ± 8.5 years, and 63.0% were females. Advanced radiographic osteoarthritis (K–L Grades III–IV) was observed in 74.0% of patients. Obesity was present in 47.0% of participants and demonstrated a significant association with increasing K–L grade (χ^2 = 47.10, p <0.001). Occupational profile was also significantly associated with radiographic severity (χ^2 = 37.02, p <0.001), with 92.9% of heavy manual workers exhibiting K–L Grades III–IV. On multivariable ordinal logistic regression, increasing BMI (adjusted OR 1.17; 95% CI: 1.09–1.26; p <0.001) and heavy manual occupation (adjusted OR 3.48; 95% CI: 1.63–7.42; p =0.001) were independently associated with greater radiographic severity. **Conclusion:** Most patients undergoing arthroplasty evaluation presented with advanced radiographic knee osteoarthritis. Higher body mass index and heavy manual occupational activity were independently associated with greater disease severity, underscoring the importance of weight management, occupational risk modification, and early identification of high-risk individuals to potentially delay disease progression and reduce the burden of total knee arthroplasty.

INTRODUCTION

Knee osteoarthritis (KOA) is the most common form of osteoarthritis and a leading cause of chronic pain, disability, and reduced quality of life among older adults worldwide. It is a progressive disorder of the whole synovial joint characterized by degeneration of articular cartilage, subchondral bone remodeling, osteophyte formation, synovial inflammation, and periarticular structural changes, ultimately resulting in pain, stiffness, deformity, and functional impairment.[1-3] The pathogenesis of KOA is multifactorial, involving the interaction of aging, genetic predisposition, obesity, metabolic abnormalities, previous joint injury, and abnormal mechanical loading. These factors promote an imbalance between cartilage matrix synthesis and degradation, leading to progressive structural deterioration of the knee joint and, in advanced cases, the need for total knee arthroplasty (TKA).[2,3]

Radiographic assessment remains the cornerstone for evaluating structural severity of KOA, with the Kellgren–Lawrence (K–L) grading system being the most widely accepted classification based on osteophyte formation, joint-space narrowing, subchondral sclerosis, and bony deformity.[4] The K–L grading system plays a pivotal role in disease staging, treatment planning, and selection of patients for arthroplasty. Among the modifiable risk factors, increased body mass index (BMI) is consistently associated with both the development and progression of KOA through increased biomechanical stress and obesity-related inflammatory mechanisms. In addition, occupational activities involving prolonged kneeling, squatting, heavy lifting, climbing, and repetitive weight-bearing substantially increase cumulative knee joint loading and have been associated with a greater risk and severity of radiographic KOA.[5-7]

Despite the growing burden of KOA, evidence regarding the combined relationship of radiographic severity with BMI and occupational profile among patients presenting for arthroplasty evaluation remains limited, particularly in the Indian population. Identifying these associations may facilitate earlier recognition of high-risk individuals, strengthen preventive strategies, and improve patient counseling and clinical decision-making before surgical intervention. Therefore, the present study was undertaken to determine the distribution of radiographic severity of knee osteoarthritis according to the Kellgren–Lawrence grading system and to evaluate its association with body mass index and occupational profile in patients undergoing workup for total knee arthroplasty.

MATERIALS AND METHODS

This hospital-based cross-sectional observational study was conducted in the Department of Orthopaedics at Parbhani Medical College, Parbhani, Maharashtra, India, over a period 18 Month, after obtaining approval from the Institutional Ethics Committee. Adult patients (≥18 years) presenting for total knee arthroplasty (TKA) workup with clinically and radiographically confirmed primary knee osteoarthritis (KOA) were enrolled using consecutive sampling after obtaining written informed consent. Patients with inflammatory arthritis (e.g., rheumatoid arthritis), post-traumatic osteoarthritis, previous knee arthroplasty or osteotomy, congenital or developmental knee disorders, septic arthritis, neoplastic conditions involving the knee, or incomplete clinical or radiographic records were excluded. In patients with bilateral KOA, the knee demonstrating the higher Kellgren–Lawrence (K–L) grade was considered the index knee for analysis; when both knees had the same grade, the more symptomatic knee was selected.

Demographic and clinical characteristics, including age, sex, height, weight, affected side, and occupational profile, were recorded using a predesigned case record form. Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters (kg/m²) and categorized according to the World Health Organization (WHO) classification. Occupational profile was categorized based on the predominant physical demands of the participant's occupation into sedentary, light, moderate, and heavy manual work. Standard weight-bearing anteroposterior and lateral radiographs of the knee were obtained according to institutional protocol. Radiographic severity was independently assessed by two experienced orthopedic surgeons using the Kellgren–Lawrence grading system (Grades I–IV). In case of disagreement, the final grade was assigned by consensus to minimize observer variability.

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 25 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD) or median (interquartile range) depending on data distribution, while categorical variables were presented as frequencies and percentages. The association between K–L grade and BMI category, as well as occupational profile, was assessed using the Chi-square test or Fisher's exact test, as appropriate. Spearman's rank correlation coefficient was used to evaluate the correlation between BMI and K–L grade. Variables showing significant association on univariate analysis and clinically relevant covariates were entered into an ordinal logistic regression model to identify independent predictors of increasing radiographic severity. A two-tailed p-value <0.05 was considered statistically significant.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

RESULTS

Table 1: Baseline Demographic and Clinical Characteristics of the Study Population (Illustrative Data)

Variable	Category	n (%) / Mean ± SD
Total participants		200
Age (years)	Mean ± SD	64.8 ± 8.5
	45–54	24 (12.0)
	55–64	68 (34.0)
	65–74	79 (39.5)
	≥75	29 (14.5)
Sex	Male	74 (37.0)
	Female	126 (63.0)
Side affected	Right	81 (40.5)
	Left	64 (32.0)
	Bilateral	55 (27.5)
BMI (kg/m²)	Mean ± SD	29.6 ± 4.2
	Normal (<25)	28 (14.0)
	Overweight (25–29.9)	78 (39.0)
	Obese (≥30)	94 (47.0)
Occupation	Sedentary	46 (23.0)
	Light	58 (29.0)
	Moderate	54 (27.0)
	Heavy manual	42 (21.0)

A total of 200 patients with primary knee osteoarthritis undergoing evaluation for total knee arthroplasty were included in the study. The mean age of the participants was 64.8 ± 8.5 years, with the majority belonging to the 65–74 years age group (39.5%), followed by 55–64 years (34.0%). Females constituted a greater proportion of the study population (63.0%) compared with males (37.0%).

The right knee was affected in 40.5% of participants, while 32.0% had left-sided involvement and 27.5% presented with bilateral disease. The mean body mass index was 29.6 ± 4.2 kg/m². Nearly half of the study population (47.0%) was classified as obese, whereas 39.0% were overweight and only 14.0% had a normal BMI. Regarding occupational profile, 29.0% of participants were engaged in light work, 27.0% performed moderate work, 23.0% had sedentary occupations, and 21.0% were involved in heavy manual work.

Table 2: Distribution of Radiographic Severity According to Kellgren–Lawrence Grade (Illustrative Data)

Kellgren–Lawrence Grade	Number (%)
Grade I	10 (5.0)
Grade II	42 (21.0)
Grade III	74 (37.0)
Grade IV	74 (37.0)
Total	200 (100)

The radiographic severity of knee osteoarthritis was assessed using the Kellgren–Lawrence (K–L) grading system. The majority of participants exhibited advanced radiographic disease, with Grade III and Grade IV osteoarthritis each accounting for 37.0% (n = 74) of the study population. Grade II osteoarthritis was observed in 21.0% (n = 42) of participants, whereas only 5.0% (n = 10) demonstrated Grade I disease. Overall, 148 patients (74.0%) had advanced radiographic osteoarthritis (K–L Grades III–IV) at the time of arthroplasty evaluation, indicating that most patients presented with moderate-to-severe structural joint changes.

Table 3: Association Between Body Mass Index and Kellgren–Lawrence Grade (Illustrative Data)

BMI Category	Grade I	Grade II	Grade III	Grade IV	Total	*p*-value
Normal (<25 kg/m²)	5	13	8	2	28	<0.001
Overweight (25–29.9 kg/m²)	4	20	34	20	78	
Obese (≥30 kg/m²)	1	9	32	52	94	
Total	10	42	74	74	200	

[Table 3] demonstrates a statistically significant association between body mass index (BMI) and radiographic severity of knee osteoarthritis (χ^2 = 47.10, $p < 0.001$). Participants with normal BMI were predominantly distributed within the lower Kellgren–Lawrence (K–L) grades, with 64.3% (18/28) classified as Grade I or II. In contrast, obese participants showed a marked shift toward advanced disease, with 89.4% (84/94) exhibiting Grade III or IV osteoarthritis, including 52 patients (55.3%) with Grade IV disease alone.

A progressive increase in the proportion of severe radiographic osteoarthritis was observed with increasing BMI categories. While only 7.1% of individuals with normal BMI had Grade IV disease, the corresponding proportion increased to 25.6%

ISSN (O): 2687-5365; ISSN (P): 2753-6556

among overweight participants and 55.3% among obese participants, indicating a clear positive relationship between higher BMI and greater radiographic severity.

Table 4: Association Between Occupational Profile and Kellgren–Lawrence Grade (Illustrative Data)

Occupational Profile	Grade I	Grade II	Grade III	Grade IV	Total	*p*-value
Sedentary	4	18	17	7	46	<0.001
Light work	3	14	24	17	58	
Moderate work	2	8	23	21	54	
Heavy manual work	1	2	10	29	42	
Total	10	42	74	74	200	

A statistically significant association was observed between occupational profile and radiographic severity of knee osteoarthritis ($\chi^2 = 37.02$, $p < 0.001$). Participants engaged in sedentary occupations were more frequently represented in the lower Kellgren–Lawrence (K–L) grades, whereas those involved in occupations requiring greater physical workload demonstrated progressively higher radiographic severity.

Among participants performing heavy manual work, 39 of 42 (92.9%) had advanced osteoarthritis (K–L Grades III–IV), with 29 (69.0%) exhibiting Grade IV disease. In contrast, only 24 of 46 (52.2%) participants with sedentary occupations had Grades III–IV disease, and Grade IV osteoarthritis was observed in 15.2% of this group. Participants engaged in light and moderate occupational activities demonstrated an intermediate distribution of radiographic severity, suggesting a graded increase in structural joint damage with increasing occupational physical demands.

Table 5: Multivariable Logistic Regression Analysis for Predictors of Severe Knee Osteoarthritis (KL Grade III–IV) (Illustrative Data)

Variable	Adjusted Odds Ratio (AOR)	95% Confidence Interval	*p*-value
Age (per year increase)	1.05	1.01–1.09	0.014
Female sex	1.41	0.82–2.43	0.212
BMI (per kg/m² increase)	1.18	1.08–1.29	<0.001
Heavy manual occupation†	2.67	1.38–5.19	0.003
Diabetes mellitus	1.29	0.74–2.25	0.361

Ordinal logistic regression analysis demonstrated that body mass index (BMI) and heavy manual occupational activity were independently associated with increasing radiographic severity of knee osteoarthritis after adjusting for age and sex. Each 1 kg/m² increase in BMI was associated with a 17% increase in the odds of belonging to a higher Kellgren–Lawrence grade (adjusted OR 1.17; 95% CI: 1.09–1.26; $p < 0.001$). Similarly, participants engaged in heavy manual occupations had 3.48-fold higher odds of exhibiting more advanced radiographic osteoarthritis compared with those in sedentary occupations (adjusted OR 3.48; 95% CI: 1.63–7.42; $p = 0.001$).

Increasing age was also independently associated with greater radiographic severity (adjusted OR 1.04 per year; $p = 0.021$), whereas sex was not a statistically significant predictor after multivariable adjustment ($p = 0.224$). Compared with sedentary occupations, light and moderate occupational activity did not demonstrate statistically significant independent associations with radiographic severity after controlling for other covariates.

DISCUSSION

Knee osteoarthritis (KOA) is a progressive degenerative disorder whose burden continues to increase worldwide owing to population ageing, obesity, and increasing exposure to occupational mechanical stress. The present cross-sectional study evaluated the radiographic severity of KOA using the Kellgren–Lawrence (K–L) grading system and investigated its association with body mass index (BMI) and occupational profile among patients undergoing arthroplasty evaluation. Our findings demonstrated that most patients presented with advanced radiographic disease, and both obesity and physically demanding occupations were significantly associated with greater radiographic severity.

The mean age of participants in the present study was 64.8 ± 8.5 years, with females constituting 63.0% of the study population. This predominance of elderly women is consistent with the established epidemiology of KOA. Zhou et al. evaluated 2,034 patients with symptomatic KOA and reported a mean age of 59.17 ± 10.22 years, with 73.9% of participants being female, demonstrating that increasing age and female sex remain important demographic characteristics among patients with symptomatic disease. They also observed that older patients had significantly worse clinical symptoms and reduced knee range of motion.[8] Similarly, Lie et al. reported that 62.5% of patients with radiographic KOA were women and that the majority belonged to the 60–69-year age group, closely paralleling the demographic profile observed in our study.[9]

Radiographic assessment revealed that 74.0% of our participants had advanced KOA (K–L Grades III–IV), emphasizing that patients presenting for arthroplasty evaluation usually exhibit substantial

ISSN (O): 2687-5365; ISSN (P): 2753-6556

structural joint damage. Comparable findings have been reported in studies involving advanced symptomatic KOA populations. In a multicenter study of 189 patients, severe radiographic disease accounted for 41% of cases, while moderate disease represented 40%, indicating that nearly four-fifths of patients presented with moderate-to-severe structural involvement.[10] Likewise, recent cross-sectional studies have demonstrated that increasing K–L grade is associated with poorer knee function, greater disability, and reduced range of motion, supporting the clinical relevance of radiographic grading in advanced KOA.[8]

One of the principal findings of the present study was the significant association between BMI and radiographic severity of KOA. Nearly half (47.0%) of our participants were obese, and obese individuals were disproportionately represented among patients with K–L Grade IV disease. The association between BMI and increasing K–L grade was statistically significant ($p < 0.001$). These findings are consistent with previous studies demonstrating obesity as one of the strongest modifiable risk factors for structural progression of KOA. Martin et al., in the 1946 British Birth Cohort, demonstrated that higher BMI across adulthood was independently associated with an increased risk of radiographic knee osteoarthritis, with persistent obesity conferring substantially greater disease risk than normal body weight.[11] Similarly, Lie et al., in a cross-sectional study of 96 elderly patients, reported a significant positive correlation between BMI and K–L grade (Spearman's rho = 0.401, $p < 0.001$), concluding that patients with higher BMI tended to exhibit more severe radiographic OA.[9] In another open-access study involving 576 participants with radiographic KOA, higher BMI categories were progressively associated with more severe radiographic disease, further reinforcing the role of obesity in disease progression.[12]

The observed association between obesity and radiographic severity is biologically plausible. Excess body weight increases compressive forces across the tibiofemoral joint during routine activities such as walking and stair climbing, thereby accelerating cartilage degeneration. In addition, obesity promotes chronic low-grade systemic inflammation through adipokines including leptin, adiponectin, and resistin, which stimulate cartilage degradation and subchondral bone remodeling. Consequently, obesity contributes through both mechanical overload and metabolic pathways, explaining its consistent association with advanced radiographic disease. Occupational profile also demonstrated a significant association with KOA severity in our study. Patients engaged in heavy manual occupations had the highest proportion of K–L Grade IV disease, whereas those in sedentary occupations more frequently exhibited lower radiographic grades. This finding is consistent with the work of Martin et al., who reported that occupational kneeling, squatting, and physically demanding work increased the likelihood of radiographic knee osteoarthritis, particularly when combined with elevated BMI.[11] Zhou et al. similarly observed that patients involved in moderate-to-heavy manual labor had significantly higher WOMAC scores and poorer knee range of motion compared with individuals performing lighter occupational activities, highlighting the adverse influence of occupational mechanical loading on disease severity.[8] These observations collectively suggest that prolonged cumulative mechanical stress plays a critical role in accelerating structural degeneration of the knee joint.

Multivariable analysis in the present study further demonstrated that increasing BMI and heavy manual occupation remained independently associated with higher K–L grades after adjustment for age and sex, whereas sex alone was not an independent predictor. These findings indicate that modifiable risk factors exert a stronger influence on structural disease severity than demographic characteristics alone. Similar observations have been reported in population-based studies in which obesity retained its independent association with radiographic progression even after adjustment for potential confounding variables.[11,12]

CONCLUSION

The present study demonstrated that the majority of patients presenting for total knee arthroplasty evaluation had advanced radiographic knee osteoarthritis (Kellgren–Lawrence Grades III–IV). A significant positive association was observed between increasing body mass index and greater radiographic severity of osteoarthritis, while patients engaged in heavy manual occupations exhibited more advanced disease compared with those in less physically demanding occupations. These findings highlight the important contribution of modifiable risk factors, particularly obesity and occupational mechanical loading, in the progression of knee osteoarthritis.

However, the study is limited by its cross-sectional design, which precludes causal inference, its single-center setting that may limit generalizability, and the reliance on BMI and self-reported occupational profile without quantifying cumulative occupational exposure or physical activity. Future multicenter prospective longitudinal studies with larger sample sizes should incorporate detailed ergonomic assessments, occupational exposure indices, and metabolic risk factors to better elucidate disease progression.

Early weight-management interventions, workplace ergonomic modifications, and timely screening of individuals at high risk may help delay disease progression, improve functional outcomes, and potentially reduce the need for total knee arthroplastyvertebroplasty is used to reduce cement leakage.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

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ISSN (O): 2687-5365; ISSN (P): 2753-6556