Original Research Article

Risk factors for medial and lateral compartment osteoarthritis of the knee: a cross-sectional analysis

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ABSTRACT

Background: Knee osteoarthritis (OA) is a leading cause of disability among older adults worldwide. Compartment-specific involvement of the knee joint, particularly medial and lateral compartments, may be influenced by distinct biomechanical and demographic risk factors. Objective of the study was to assess the socio-demographic, radiographic, and biomechanical risk factors associated with medial and lateral compartment knee osteoarthritis among adult patients.
Methods: A hospital-based cross-sectional study was conducted among 96 patients diagnosed with knee osteoarthritis. Socio-demographic data, clinical history, and radiographic findings were collected. Radiographic severity was assessed using Kellgren–Lawrence and Ahlback grading systems. Univariate and multivariate logistic regression analyses were performed to identify risk factors for compartment-specific osteoarthritis.
Results: The mean age of participants was 59.59±8 years, with 86.5% aged above 50 years. Medial compartment involvement showed higher frequencies of osteophyte formation (86.5%), joint space narrowing (66.7%), and advanced Kellgren–Lawrence grades. Male sex (adjusted OR=3.09; p=0.031) was an independent predictor of medial compartment OA, while male sex demonstrated an inverse association with lateral compartment OA (adjusted OR=0.38; p=0.038).
Conclusions: Medial compartment knee osteoarthritis was more prevalent and severe than lateral compartment involvement. Sex and knee alignment played significant roles in compartment-specific disease patterns. These findings highlight the need for targeted preventive and therapeutic strategies.

Keywords: Knee osteoarthritis, Medial compartment, Lateral compartment, Radiographic grading, Ahlback classification, Knee alignment

INTRODUCTION

Knee osteoarthritis (OA) is one of the most prevalent chronic musculoskeletal disorders and a leading cause of pain, disability, and reduced quality of life among adults worldwide. It is characterized by progressive degeneration of articular cartilage, subchondral bone remodeling, osteophyte formation, and synovial inflammation, ultimately resulting in impaired joint function and mobility. Globally, the burden of knee OA has increased substantially due to population aging, rising obesity rates, and increased life expectancy, making it a major public health concern in both developed and developing countries.[1,2] Epidemiological evidence suggests that knee OA contributes significantly to years lived with disability, particularly among individuals aged over 50 years.[3] Radiographically, knee OA is a heterogeneous disease that may affect different compartments of the tibiofemoral joint, most commonly the medial compartment, followed by the lateral compartment and, less frequently, the patellofemoral compartment. Compartment-specific involvement is clinically important because it reflects distinct biomechanical loading patterns and may influence disease progression, symptom severity, and treatment strategies.[4] Medial compartment OA is generally more prevalent and is often associated with varus knee alignment, which increases mechanical stress across the medial tibiofemoral joint during weight-bearing activities.[5,6] In contrast, lateral compartment OA is less common and has been linked to valgus alignment and different biomechanical and anatomical risk profiles. Several socio-demographic and clinical factors have been consistently associated with knee OA, including advancing age, sex, body mass index (BMI), previous knee trauma, and occupational or lifestyle-related mechanical stress.[7,8] Age-related changes in cartilage composition and repair capacity play a central role in OA pathogenesis, while excess body weight increases joint loading and accelerates cartilage degeneration. Sex differences have also been reported, with women generally showing a higher overall prevalence of knee OA, although some studies suggest that men may be more prone to medial compartment involvement, potentially due to differences in knee alignment, muscle strength, and occupational exposure.[9,10] Radiographic assessment remains a cornerstone in the diagnosis and staging of knee OA, despite recognized limitations in correlating structural changes with clinical symptoms. The Kellgren–Lawrence (KL) grading system is the most widely used method for classifying the severity of radiographic OA based on osteophyte formation, joint space narrowing, sclerosis, and deformity.[11] The Ahlback grading system, which emphasizes joint space loss and bone attrition, is also frequently used to assess advanced disease, particularly in the tibiofemoral compartments. Previous studies have demonstrated that radiographic severity often differs between medial and lateral compartments, with the medial side more commonly exhibiting advanced degenerative changes. In low- and middle-income countries, including Bangladesh, data on compartment-specific knee OA and its associated risk factors remain limited. Community- and hospital-based studies have reported a substantial burden of musculoskeletal disorders and knee OA in both urban and rural populations, yet detailed analyses focusing on medial versus lateral compartment involvement are scarce.[12,13] Understanding these patterns is essential for developing targeted preventive measures, optimizing conservative management, and guiding surgical decision-making such as unicompartmental versus total knee arthroplasty. Given these gaps, the present study was designed to assess socio-demographic, radiographic, and biomechanical risk factors associated with medial and lateral compartment knee osteoarthritis among adult patients attending a tertiary care hospital. By examining compartment-specific patterns of radiographic severity and their predictors, this study aims to contribute to a more nuanced understanding of knee OA and to inform context-appropriate prevention and management strategies.

METHODS

This study was cross-sectional analytical study. It was conducted over a period of six months, from November 2019 to April 2020, sample size for this study was 96, to assess compartment-specific risk factors of knee osteoarthritis among adult patients. The study was carried out in the Department of Medicine, Chittagong Medical College Hospital and Department of Radiology and imaging, Chittagong Medical College Hospital.

Inclusion criteria

Adult patients aged 40 years and above. Clinically and radiographically diagnosed cases of knee osteoarthritis. Patients willing to provide informed consent

Exclusion criteria

Patients with inflammatory arthritis (e.g., rheumatoid arthritis). History of knee joint infection or congenital knee deformities. Previous knee surgery or joint replacement. Patients with incomplete clinical or radiographic data.

Data collection procedure

Data were collected using a pre-structured and pre-tested data collection sheet through face-to-face interviews, clinical examination, and radiographic assessment. Socio-demographic variables such as age, sex, residence, smoking status, and body mass index (BMI) were recorded. Clinical history included duration of symptoms and history of knee trauma. Standardized anteroposterior weight-bearing radiographs of the knee were obtained and evaluated by experienced radiologists.

Statistical analysis

Data were entered and analyzed using statistical package for the social sciences (SPSS) software. Descriptive statistics were used to summarize socio-demographic,

clinical, and radiographic characteristics. Categorical variables were presented as frequencies and percentages, while continuous variables were expressed as mean±standard deviation. Univariate logistic regression analysis was performed to identify potential risk factors for compartment-specific knee osteoarthritis. Variables with statistical significance were subsequently entered into a multivariate logistic regression model to determine independent predictors. A p value <0.05 was considered statistically significant.

RESULTS

Table 1 presents the socio-demographic and clinical characteristics of the 96 patients included in the study. The mean age of the participants was 59.59±8 years, and the majority of patients (86.5%) were older than 50 years. In terms of sex distribution, 44.8% were male and 55.2% were female. Regarding place of residence, most patients were from urban areas (43.8%), followed by rural (29.2%) and semi-urban areas (27.1%). A history of smoking was present in 45.8% of the patients. The mean body mass index (BMI) was 24.93±2.65 kg/m². Previous history of knee trauma was reported by 20.8% of patients, whereas 79.2% had no such history.

Table 1: Socio-demographic and clinical characteristics of the study population (n=96).

Variables	Frequency (%)/mean±SD
Age (years)	59.59±8
Age >50 years	83 (86.5)
Sex	
Male	43 (44.8)
Female	53 (55.2)
Residence	
Urban	42 (43.8)
Semi-urban	26 (27.1)
Rural	28 (29.2)
Smoking status	
Smoker	44 (45.8)
Non-smoker	52 (54.2)
Body mass index (kg/m²)	24.93±2.65
History of knee trauma	
Present	20 (20.8)
Absent	76 (79.2)

Table 2 shows the distribution of radiographic features according to medial and lateral knee compartment involvement. Definite osteophyte formation was more frequent in the medial compartment (86.5%) compared to the lateral compartment (59.4%). Joint space narrowing of less than 3 mm was observed in 66.7% of medial compartments and 58.3% of lateral compartments. Subchondral sclerosis was more commonly detected in the medial compartment (16.7%) than in the lateral compartment (4.1%). Bony attrition measuring 5–10 mm was identified in 81.8% of medial compartments and

71.4% of lateral compartments, indicating greater structural involvement of the medial compartment.

Table 3 illustrates the distribution of KL grades in the medial and lateral compartments of the knee. In the medial compartment, the highest proportion of patients were classified as grade III (39.1%), followed by grade II (34.5%) and grade IV (23.0%). In contrast, the lateral compartment showed a predominance of grade II disease (63.9%), with relatively fewer patients classified as grade III or grade IV. This distribution suggests more advanced radiographic disease in the medial compartment compared to the lateral compartment.

Table 2: Radiographic characteristics according to knee compartment involvement.

Radiographic feature	Medial compartment N (%)	Lateral compartment N (%)
Definite osteophytes	83 (86.5)	57 (59.4)
Joint space narrowing (<3 mm)	64 (66.7)	56 (58.3)
Subchondral sclerosis	16 (16.7)	3 (4.1)
Bony attrition (5–10 mm)	72 (81.8)	50 (71.4)

Table 3: Distribution of Kellgren–Lawrence (KL) grades by compartment.

KL grade	Medial compartment N (%)	Lateral compartment N (%)
Grade I	3 (3.4)	3 (8.3)
Grade II	30 (34.5)	23 (63.9)
Grade III	34 (39.1)	6 (16.7)
Grade IV	20 (23.0)	4 (11.1)

Table 4: Ahlback's radiographic grading of knee osteoarthritis.

Ahlback grade	Medial compartment N (%)	Lateral compartment N (%)
Grade I	22 (40.0)	1 (12.5)
Grade II	9 (16.4)	2 (25.0)
Grade III	3 (5.5)	1 (12.5)
Grade IV	18 (32.7)	4 (50.0)
Grade V	3 (5.5)	0 (0.0)

Table 4 presents the compartment-wise severity of knee osteoarthritis according to Ahlback's radiographic grading system. In the medial compartment, grade I changes were most frequent (40.0%); however, a substantial proportion of patients exhibited advanced disease, with 32.7% classified as grade IV and 5.5% as grade V. In the lateral

compartment, grade IV changes were most common (50.0%), while no patients were classified as grade V. These findings further confirm the predominance of severe radiographic changes in the medial compartment.

Table 5 summarizes the univariate analysis of potential risk factors for predominantly medial compartment osteoarthritis. Varus knee alignment was identified as a significant risk factor for medial compartment involvement (odds ratio [OR]=1.26; p=0.01). Male sex was also significantly associated with an increased risk of medial compartment osteoarthritis (OR=3.43; p=0.018). Age greater than 60 years was considered as the reference category. Overweight status based on BMI did not show a statistically significant association with medial compartment osteoarthritis (p=0.128).

Table 5: Risk factors for predominantly medial compartment osteoarthritis.

Variables	Odds ratio (95% CI)	P value
Varus alignment	1.26 (1.11–1.56)	0.01*
Male sex	3.43 (1.24–9.48)	0.018*
Age >60 years	Reference	-
BMI (overweight)	1.87 (0.70–5.04)	0.128

Table 6 presents the results of multivariate logistic regression analysis identifying independent predictors of compartment-specific osteoarthritis. For medial compartment osteoarthritis, male sex remained a statistically significant independent predictor (adjusted OR=3.09; p=0.031), while varus alignment showed a borderline association. In contrast, for lateral compartment osteoarthritis, male sex demonstrated a significant inverse association (adjusted OR=0.38; p=0.038). Valgus alignment did not show a statistically significant association with lateral.

Table 6: Multivariate analysis of predictors for compartment-specific osteoarthritis.

Variables	Adjusted odds ratio (95% CI)	P value
Medial compartment OA		
Male sex	3.09 (1.08–8.71)	0.031*
Varus alignment	1.28 (1.09–1.58)	0.08
Lateral compartment OA		
Male sex	0.38 (0.16–0.95)	0.038*
Valgus alignment	1.68 (0.91–2.29)	0.16

DISCUSSION

This study demonstrates clear compartment-specific differences in knee osteoarthritis when the numerical findings from all tables are compared side by side. Across demographic characteristics, radiographic features, grading systems, and risk factor analyses, medial compartment osteoarthritis consistently shows greater

frequency and more advanced structural damage than lateral compartment disease. The baseline characteristics establish the clinical background for compartmental comparison. The mean age of participants was 59.59±8 years, and a large majority of patients were older than 50 years (83, 86.5%), reinforcing age as a major determinant of knee osteoarthritis.[1,3] Females were slightly more represented than males (53, 55.2% versus 43, 44.8%), yet later tables reveal that sex influenced the *pattern* of compartment involvement rather than overall disease occurrence. The mean BMI was 24.93±2.65 kg/m², placing most patients in the overweight range, although BMI did not significantly differentiate medial from lateral compartment disease, suggesting that mechanical alignment and sex-related factors were more influential.[8,14] Radiographic feature comparison in reveals consistently higher structural involvement in the medial compartment. Definite osteophyte formation was present in 83 medial compartments (86.5%) compared with 57 lateral compartments (59.4%). Joint space narrowing below 3 mm affected 64 medial compartments (66.7%) versus 56 lateral compartments (58.3%). Subchondral sclerosis showed a marked disparity, being present in 16 medial compartments (16.7%) compared with only 3 lateral compartments (4.1%). Bony attrition measuring 5–10 mm was also more frequent medially, observed in 72 cases (81.8%) compared with 50 cases (71.4%) laterally. These findings indicate greater cumulative mechanical stress and remodeling in the medial compartment.[5,6] The KL grade distribution further clarifies severity differences. Early disease (Grade I) was uncommon in both compartments but relatively higher in the lateral compartment, with 3 cases (8.3%) compared with 3 cases (3.4%) medially. Grade II disease showed a strong lateral predominance, affecting 23 lateral compartments (63.9%) versus 30 medial compartments (34.5%). In contrast, advanced disease was concentrated in the medial compartment: grade III was observed in 34 medial compartments (39.1%) compared with 6 lateral compartments (16.7%), while grade IV affected 20 medial compartments (23.0%) versus only 4 lateral compartments (11.1%). This progressive shift toward higher grades medially reflects more aggressive disease progression.[15,16] Ahlback grading highlights these differences even more distinctly. Grade I disease was substantially more common in the medial compartment, affecting 22 patients (40.0%), compared with only 1 patient (12.5%) laterally. Grade II changes were seen in 9 medial compartments (16.4%) versus 2 lateral compartments (25.0%), while grade III disease affected 3 medial compartments (5.5%) and 1 lateral compartment (12.5%). Advanced disease again showed medial dominance in absolute numbers: grade IV was present in 18 medial compartments (32.7%) compared with 4 lateral compartments (50.0%). Importantly, grade V disease was observed exclusively in the medial compartment, affecting 3 patients (5.5%), with no lateral cases recorded. The exclusive presence of end-stage disease medially underscores the medial compartment's vulnerability to severe degeneration.[4,17] Risk factor analysis provides a biomechanical explanation for these

patterns. Varus alignment was significantly associated with medial compartment osteoarthritis (OR 1.26, p=0.01), supporting the role of increased medial load transmission during weight bearing.[5] Male sex showed a strong association with medial disease (OR 3.43, p=0.018), while overweight status did not reach statistical significance, suggesting that alignment-related forces outweighed body mass effects in this population. Multivariate analysis confirms these associations. Male sex remained an independent predictor of medial compartment osteoarthritis (adjusted OR 3.09, p=0.031), whereas varus alignment showed a borderline association. In contrast, male sex demonstrated a significant inverse association with lateral compartment osteoarthritis (adjusted OR 0.38, p=0.038), indicating that lateral compartment disease was relatively more frequent among females. Valgus alignment showed a positive but non-significant association with lateral disease, likely reflecting limited statistical power rather than absence of biomechanical influence.[6,18] When all table options are interpreted together, a consistent and biologically plausible pattern emerges. Medial compartment osteoarthritis is characterized by higher frequencies of osteophytes, greater joint space loss, higher KL and Ahlback grades, and exclusive presence of end-stage disease. Lateral compartment osteoarthritis, by contrast, is more commonly confined to moderate severity levels and demonstrates weaker associations with identifiable risk factors. These findings reinforce the concept that knee osteoarthritis is fundamentally compartment-specific and highlight the importance of targeted evaluation and management strategies.[1,9,10]

CONCLUSION

This study demonstrates that medial compartment knee osteoarthritis is more prevalent and structurally severe than lateral compartment disease. Medial involvement showed higher frequencies of osteophyte formation, joint space narrowing, advanced KL and Ahlback grades, and exclusive presence of end-stage degeneration. Male sex and varus knee alignment were identified as important predictors of medial compartment osteoarthritis, whereas lateral compartment involvement was relatively more common among females and generally confined to moderate radiographic severity. These findings highlight the compartment-specific nature of knee osteoarthritis and emphasize the importance of early identification of alignment-related risk factors to guide targeted preventive, conservative, and surgical management strategies.

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