Correlation between Functional Status and Radiographic Grading in Patients with Osteoarthritis of Knee: An Observational Study

Manoj Nepali,[1] Sushil Rana Magar,[2] Bikash Thapa,[3] Adarsha Mahaseth,[2] Alok Singh,[4] Sujan Shrestha,[5] Amit Chand[6]

[1]Norvic International Hospital, Thapathali, Kathmandu, Nepal, [2]Nepalese Army Institute of Health Sciences, Chhauni, Kathmandu, Nepal, [3]Department of Orthopaedics, Nepal APF Hospital, Balambu, Kathmandu, Nepal, [4]Nepal Police Hospital, Krishna Dhara Marg, Kathmandu, Nepal, [5]Kirtipur Hospital, Kirtipur, Kathmandu, Nepal, [6]Patan Academy of Health Sciences, Lagankhel, Lalitpur, Nepal.

ABSTRACT

Introduction: Knee osteoarthritis is a common cause of pain and functional limitation. Previous studies have reported inconsistent relationships between radiographic severity and functional impairment. The aim of this study was to determine the correlation between functional status and radiographic grading in patients with knee osteoarthritis.

Methods: A hospital-based cross-sectional study was conducted in Kathmandu, Nepal. Adults aged 40-90 years with knee osteoarthritis diagnosed using the American College of Rheumatology criteria were included. Functional status was evaluated using the Western Ontario and McMaster Universities Osteoarthritis Index and the Timed Up and Go test. Radiographic severity was graded using the Kellgren-Lawrence system. Correlations between demographic, functional, and radiographic variables were analyzed.

Results: A total of 185 patients were included. Kellgren-Lawrence grade showed a significant positive correlation with WOMAC score (r=0.55, p<0.001) and TUG score (r=0.71, p<0.001). Age demonstrated a positive correlation with WOMAC score (r=0.41, p<0.001) and Kellgren-Lawrence grade (r=0.64, p<0.001). Body mass index showed a weak positive correlation with WOMAC score (r=0.25, p=0.0006) and no statistically significant correlation with Kellgren-Lawrence grade (r=0.14, p=0.058).

Conclusions: In this study, poorer functional status was positively associated with greater radiographic severity in patients with knee osteoarthritis. Objective functional assessment using the Timed Up and Go test may complement radiographic evaluation in clinical practice; however, the findings should be interpreted as associations rather than causal relationships.

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Correspondence:
Name: Dr Bikash Thapa
Affiliation: Nepal APF Hospital, Balambu, Kathmandu, Nepal.
Email: drbikashthapa@gmail.com
Phone: +977-9863263777

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INTRODUCTION

Knee osteoarthritis is a chronic degenerative joint disorder characterized by pain, stiffness, and functional limitation, and is a leading and increasing cause of global disability, particularly among older adults.[1] Radiographic severity is commonly assessed using the Kellgren-Lawrence grading system; however, evidence suggests that structural changes on X-ray do not consistently correspond with symptom severity or functional impairment. Population-based studies and systematic reviews have demonstrated discordance between radiographic findings and clinical presentation, with pain and disability frequently occurring independently of radiographic grade.[2-6] This inconsistency between radiographic severity and clinical status highlights a gap in the comprehensive evaluation of knee osteoarthritis and underscores the need to incorporate functional assessment alongside imaging findings. The aim of this study was to determine the correlation between functional status and radiographic grading in patients with knee osteoarthritis.

METHODS

This hospital-based cross-sectional observational study was conducted in the Department of Orthopedics and Trauma Surgery at Shree Birendra Hospital, Chhauni, Kathmandu, Nepal, over a period of 15 months from June, 2022 to August, 2023. Ethical approval was obtained from the Institutional Review Committee of the Nepalese Army Institute of Health Sciences (IRC-NAIHS; Ref No: 506) prior to commencement of the study. All eligible patients were informed about the objectives and procedures of the study, and written informed consent was obtained before

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enrollment.

Patients aged 40-90 years of either gender who were clinically diagnosed with knee osteoarthritis based on the American College of Rheumatology (ACR) criteria and were willing to participate were included. Patients were excluded if they had received intra-articular injections within the preceding six months, had a history of knee surgery, fractures, ligamentous or meniscal injuries, or had inflammatory, infectious, or neoplastic conditions involving the knee joint.

Functional status was assessed using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and the Timed Up and Go (TUG) test. Radiographic severity was assessed using the Kellgren-Lawrence grading system on knee radiographs. Radiographic grading was performed according to the Kellgren-Lawrence classification based on osteophyte formation, joint space narrowing, subchondral sclerosis, and bony deformity. The grading was based on radiographic features including osteophyte formation, joint space narrowing, sclerosis, and deformity. As Kellgren-Lawrence grading may be subject to observer variability, this issue was considered during interpretation of the findings and has been acknowledged as a limitation of the study.

The sample size was calculated using a correlation-based formula $n=[4(Z\alpha + Z\beta)^2 / \{\ln((1 + r)/(1 - r))\}^2] + 3$ where n is the required sample size, r is the anticipated correlation coefficient, Z_α is the standard normal deviate corresponding to the level of significance, and Z_β is the standard normal deviate corresponding to the desired study power. The anticipated correlation coefficient (r=0.236) between the TUG test and Kellgren-Lawrence grading was taken from a previous study by Özden et al.[7] With a two-sided confidence level of 95% (Z_α=1.96) and a power of 90% (Z_β=1.28), the calculated sample size was approximately 185.

Eligible participants were recruited using a non-probability convenience sampling technique from patients attending the outpatient department during the study period. Therefore, the study population represents a hospital-based sample and may include a higher proportion of symptomatic patients than the general community population.

Data were entered into Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) and analyzed using Statistical Package for the Social Sciences (SPSS) version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were summarized as mean and standard deviation, while categorical variables were expressed as frequencies and percentages. Normality was assessed using frequency histograms. Pearson's correlation coefficient was used to assess correlations between demographic, functional, and radiographic variables. A p-value of less than 0.05 was considered statistically significant. Multivariable regression analysis was not performed; therefore, the reported findings should be interpreted as unadjusted associations rather than independent or causal relationships.

RESULTS

A total of 185 patients with clinically diagnosed knee osteoarthritis were included in the analysis. Out of the total participants, 118 (63.78%) were female. The mean age was 63.48±8.61 with, 115 (62.16%) patients ages above 60 years. The mean BMI was 26.87±1.94 kg/m² and 151 (81.62%) of them were overweight (Table 1).

Table 1. Demographic characteristics of the study population (n=185).

Variable	n(%)
Age	
> 60 years	115(62.16)
Mean±SD	63.48±8.61
Sex	
Female	118(63.78)
Male	67(36.22)
BMI	
Overweight (BMI 25-30)	151(81.62)
Mean±SD	26.87±1.94

SD: Standard Deviation, BMI: Body Mass Index.

The distribution of knee involvement and area of residence showed that unilateral knee involvement, affecting either the right or left knee, was more common than bilateral involvement, with 135 (72.97%) presenting with unilateral disease. Similarly, the majority of participants were from hilly regions, accounting for 122 (65.95%).

Table 2. Radiographic severity and corresponding functional scores (n=185).

K&L Grade	n(%)	WOMAC Score (Mean±SD)	TUG Score (Mean±SD, sec)
Grade 1	22(11.89)	45.64±7.12	11.40±1.21
Grade 2	65(35.14)	51.48±6.92	13.24±1.49
Grade 3	73(39.46)	56.22±10.08	15.22±1.20
Grade 4	25(13.51)	65.44±4.44	17.00±1.54

K&L: Kellgren-Lawrence, TUG: Timed Up and Go, WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index.

Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and Timed Up and Go (TUG) scores increased progressively across Kellgren-Lawrence (K&L) grades. Mean WOMAC score increased from 45.64±7.12 in K&L Grade 1 to 65.44±4.44 in K&L Grade 4, while mean TUG score increased from 11.40±1.21 seconds to 17.00±1.54 seconds across the same grades (Table 2).

Age was correlated with WOMAC score (r = 0.41) and K&L grade (r = 0.64). BMI showed correlations with WOMAC score (r = 0.25) and K&L grade (r = 0.14). Correlations were also observed between K&L grade and WOMAC score (r = 0.55),

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K&L grade and TUG score (r = 0.71), and WOMAC score and TUG score (r = 0.73). All correlations were statistically significant except BMI and K&L grade (p = 0.058) (Table 3).

Regarding functional status, the mean WOMAC total score was 54.54±9.74, and the mean TUG score was 14.31±2.13 seconds (Table 4).

Table 3. Correlation between demographic, functional, and radiographic variables (n=185).

Variables Compared	Correlation Coefficient (r)	p-value
Age vs WOMAC Score	0.41	<0.001
Age vs K&L Grade	0.64	<0.001
BMI vs WOMAC Score	0.25	0.0006
BMI vs K&L Grade	0.14	0.058
K&L Grade vs WOMAC Score	0.55	<0.001
K&L Grade vs TUG Score	0.71	<0.001
WOMAC Score vs TUG Score	0.73	<0.001

WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index, BMI: Body Mass Index, K&L: Kellgren-Lawrence, TUG: Timed Up and Go.

Table 4. Functional status of patients based on WOMAC and TUG scores (n=185).

Parameter	Mean ± SD	Range
WOMAC Total Score	54.54 ± 9.74	16-78
WOMAC Pain Score	8.11 ± 1.69	4-15
WOMAC Stiffness Score	4.49 ± 1.00	1-7
WOMAC Physical Function Score	42.43 ± 7.01	11-56
TUG Score (seconds)	14.31 ± 2.13	7-22.96

SD: Standard Deviation, WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index, TUG: Timed Up and Go.

DISCUSSION

The present hospital-based cross-sectional study of 185 patients with knee osteoarthritis demonstrated demographic and clinical characteristics broadly consistent with regional and global evidence. The mean age of the study population was 63.48±8.61 years, with 62.16% of patients aged above 60 years, supporting the established association between advancing age and knee osteoarthritis burden. This finding is consistent with regional and international studies reporting higher osteoarthritis prevalence and severity among older adults.[8-11]

Female predominance was observed in our cohort, with females comprising 63.78% of the study population. This finding aligns with South Asian literature, where women have frequently shown a higher prevalence of knee osteoarthritis.[8-10] This may be related to hormonal, biomechanical, and sociocultural factors; however, these factors were not directly assessed in the present study.

A high burden of excess body weight was also observed, with a mean BMI of 26.87±1.94 kg/m² and 81.62% of patients classified as overweight. Similar findings have been reported in regional studies from Nepal and India,[8,9] and Bangladesh data have shown higher odds of knee osteoarthritis among overweight individuals.[11] Longitudinal evidence from the Framingham Study also supports obesity as an important risk factor for knee osteoarthritis, particularly among women.[12] In the present study, BMI showed a weak positive correlation with WOMAC score but no statistically significant correlation with K&L grade, suggesting that excess body weight may be more closely related to symptomatic or functional limitation than to radiographic severity in this cross-sectional sample.

Unilateral disease predominated in our cohort, whereas multicenter Indian data have reported a higher frequency of bilateral involvement.[13] This difference may reflect variation in disease stage, referral patterns, occupational loading, or health-seeking behavior. Patients from hilly regions constituted 65.95% of the cohort. This finding is consistent with population-based Nepalese evidence showing higher odds of knee pain and chronic knee pain among residents of mountainous areas, possibly related to biomechanical stress, terrain, and occupational demands.[14] However, the present study did not directly measure occupational exposure, walking pattern, stair climbing, load carrying, or physical activity level.

Functionally, the study population demonstrated moderate impairment, with a mean WOMAC total score of 54.54±9.74 and a mean TUG time of 14.31±2.13 seconds. Radiographically, disease severity was predominantly moderate, with K&L grades II and III accounting for nearly three-quarters of cases. These findings are comparable to Nepalese hospital-based studies reporting similar WOMAC scores, K&L grade distributions, and positive correlations between WOMAC and radiographic severity.[15,16] Indian data have also shown increasing WOMAC scores with advancing K&L grade,[17] while international evidence suggests that TUG values around 14 seconds may be observed among patients with mild-to-moderate radiographic knee osteoarthritis.[18]

In the present study, K&L grade showed a statistically significant positive correlation with both WOMAC score and TUG score. The correlation was stronger for TUG score than for WOMAC score, suggesting that objective functional mobility testing may complement patient-reported assessment in patients with knee osteoarthritis. WOMAC score also showed a strong positive correlation with TUG score, indicating that subjective functional limitation and objective mobility performance followed a similar direction of association in this cohort. However, these findings

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represent unadjusted correlations only. Multivariable regression analysis was not performed; therefore, the observed associations should not be interpreted as independent predictors or causal relationships. The use of both WOMAC and TUG is a strength of this study. WOMAC provides a patient-reported measure of pain, stiffness, and physical function, whereas TUG offers a simple objective assessment of functional mobility. Their combined use provides a broader assessment of clinical status than radiographic grading alone. This is particularly relevant because some community-based studies have

Table 5. Comparison of key findings of the present study with regional and international studies on knee osteoarthritis.

Parameter	Present study (n=185)	Findings from other studies
Mean age / age pattern	Mean age 63.48±8.61 years; 62.16% >60 years	• Mean age 58.76±11.70 years; majority 61-80 years - Shrestha et al.[8] • Highest OA prevalence ≥60 years (p=0.001) - Pal et al.[9] • Mean age 63.3±9.29 years among women ≥50 years - Hettihewa et al.[10] • OA risk markedly increased at ≥58 years (OR 13.9) - Haider et al.[11]
Sex distribution	Females 63.78%	• Females 83.2% - Shrestha et al.[8] • Higher prevalence in women (31.6% vs 28.1%) - Pal et al.[9] • Female-only cohort with high OA burden - Hettihewa et al.[10] • Slight female majority, with no significant sex difference - Haider et al.[11]
BMI / overweight	Mean BMI 26.87±1.94 kg/m²; 81.62% overweight	• Overweight 24% and obese 40.8% - Shrestha et al.[8] • BMI significantly associated with OA (p=0.04) - Pal et al.[9] • Overweight associated with higher OA odds (OR 1.9) - Haider et al.[11] • Obesity preceded OA and was associated with approximately two-fold risk in women - Felson et al.[12]
Laterality	Unilateral 72.97%; bilateral 27.03%	• Bilateral knee pain reported in approximately 66% - Sancheti et al.[13]
Geographic / ecological factors	Hilly region 65.95%	• Mountain residence independently associated with knee pain and chronic knee pain - Kshetri et al.[14]
Radiographic severity (K&L)	Grade II 35.14%, Grade III 39.46%, Grade IV 13.51%	• Predominantly Grade II-III; Grade IV approximately 16% - Sapkota et al.[15] • Grade II 34.5%, Grade III 35.1%, Grade IV 17.2% - Khanal et al.[16] • Milder disease pattern; Grade IV approximately 4.4% - Ahmed et al.[20]
WOMAC total score	54.54±9.74 (moderate impairment)	• 54.81±13.13 - Sapkota et al.[15] • Higher WOMAC scores reported with advancing K&L grade - Rajpoot et al.[17] • Moderate OA WOMAC range reported as 42-69 - Pojala et al.[19]
WOMAC-K&L relationship	Strong positive correlation (r=0.55, p<0.001)	• Strong correlation reported (r=0.73) - Sapkota et al.[15]; Khanal et al.[16] • Significant stepwise rise across grades - Rajpoot et al.[17] • No significant association reported - Ahmed et al.[20]; Cubukcu et al.[2]
TUG performance	14.31±2.13 s	• Mean TUG approximately 14 s for K&L Grade II-III; excellent reliability reported - Alghadir et al.[18]
TUG-K&L correlation	Strong positive correlation (r=0.71, p<0.001)	• Functional mobility was associated with radiographic severity - Alghadir et al.[18]
Age correlations	Age vs WOMAC r=0.41; Age vs K&L r=0.64	• Age correlated with WOMAC and K&L grade - Sapkota et al.[15] • Age associated with radiographic severity - Cubukcu et al.[2]
BMI correlations	BMI vs WOMAC weak positive correlation (r=0.25); BMI vs K&L not significant	• BMI associated with OA onset and progression in longitudinal studies - Reijman et al.[21]; Yusuf et al.[22]

K&L: Kellgren-Lawrence, TUG: Timed Up and Go, WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index, BMI: Body Mass Index.

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reported weaker or absent associations between radiographic severity and symptoms,[2,20] highlighting the heterogeneity of clinical-radiological relationships in knee osteoarthritis (Table 5).

Overall, the present findings suggest that greater radiographic severity was associated with poorer functional status in this hospital-based cohort. However, the results should be interpreted in the context of the study design. The cross-sectional nature of the study precludes assessment of temporality or causality. In addition, because the study was conducted in a hospital outpatient setting using convenience sampling, patients with more symptomatic or functionally limiting disease may have been more likely to be included, limiting generalizability to community-based populations.

Several additional limitations should be considered. First, multivariable regression analysis was not performed, and potential confounding by age, sex, BMI, physical activity, occupational loading, quadriceps strength, prior physiotherapy, analgesic use, pain sensitization, psychological factors, and comorbidities could not be fully addressed. Second, radiographic severity was assessed using plain radiographs and K&L grading, which may be subject to observer variability and may not capture early cartilage, meniscal, or soft-tissue abnormalities detectable on advanced imaging. Third, the distribution of K&L grades was uneven, with most patients classified as Grade II or III and relatively fewer patients in Grade I and Grade IV categories; this may have influenced the stability of correlation estimates across radiographic severity groups. Finally, longitudinal outcomes were not assessed, so the study cannot determine whether radiographic severity predicts future functional decline.

Despite these limitations, the study supports the clinical value of assessing both radiographic severity and functional status in patients with knee osteoarthritis. The findings suggest that TUG may be a practical adjunct to WOMAC and radiographic evaluation in routine clinical assessment, although further longitudinal and adjusted studies are needed to confirm its predictive value.

CONCLUSION

In this hospital-based cross-sectional study, poorer functional status was significantly associated with greater radiographic severity in patients with knee osteoarthritis. The Timed Up and Go test showed a strong positive correlation with Kellgren-Lawrence grading and may serve as a useful objective adjunct to WOMAC and radiographic assessment. However, these findings represent unadjusted associations and should not be interpreted as causal or predictive relationships. Further longitudinal studies with adjustment for potential confounders are needed to confirm these findings and evaluate their clinical applicability.

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