

Original Research Article

Beyond radiographic severity: interrelationship of age, foot progression angle and psychological distress with WOMAC outcome in knee osteoarthritis

Aavrati Rastogi¹, Roop B. Kalia^{1*}, Anindya Das²

¹Department of Orthopedics, AIIMS, Rishikesh, Uttarakhand, India

²Department of Psychiatry, AIIMS Rishikesh, Uttarakhand, India

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*Correspondence:

Roop B. Kalia,

E-mail: roop.orth@aiimsrishikesh.edu.in

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ABSTRACT

Background: Knee osteoarthritis (KOA) is a progressive degenerative joint disorder characterized by chronic pain, functional limitation, and impaired quality of life. Emerging evidence indicates that radiographic severity alone inadequately explains symptom burden, thereby highlighting the contribution of biomechanical and psychosocial determinants to functional disability. The objective is to investigate the interrelationship of age, foot progression angle (FPA), and psychological distress with functional disability measured using the WOMAC Index in patients with knee osteoarthritis.

Methods: A cross-sectional observational study was conducted among 108 patients aged 45–70 years with unilateral or bilateral knee osteoarthritis graded using the Kellgren–Lawrence grading system. Functional disability was evaluated using the WOMAC Index, psychological distress using the PHQ-9 and GAD-7, and resilience using the Brief Resilience Scale. Foot progression angle was assessed during gait analysis. Pearson correlation and multivariate linear regression analyses were performed.

Results: Advancing age and greater deviations in foot progression angle were significantly associated with worsening WOMAC-derived functional disability. Psychological distress exhibited weak-to-moderate positive correlations with WOMAC outcome, whereas resilience demonstrated an inverse relationship. Multivariate regression analysis identified foot progression angle and psychological distress as independent contributors to functional limitation beyond the effects of radiographic severity.

Conclusions: Functional impairment in knee osteoarthritis extends beyond radiographic disease severity and appears to be influenced by gait biomechanics and psychosocial factors. A comprehensive multidimensional assessment may improve individualized rehabilitation and long-term functional outcomes.

Keywords: Knee osteoarthritis, WOMAC, Foot progression angle, Psychological distress, Gait biomechanics, Depression, Anxiety, Functional disability

INTRODUCTION

Knee osteoarthritis (KOA) is one of the most prevalent musculoskeletal disorders and a major contributor to chronic pain, disability, and reduced functional

independence among middle-aged and elderly populations worldwide.^{1,2}

Traditionally, disease severity has been evaluated radiographically using the Kellgren–Lawrence grading

system; however, radiographic findings frequently demonstrate limited concordance with patient-reported pain and disability.^{3,4}

The pathophysiology of KOA is increasingly recognized as multifactorial, involving not only cartilage degeneration and structural joint alterations but also biomechanical dysfunction, altered gait mechanics, neuromuscular imbalance, and psychosocial distress.^{5,6} Among biomechanical variables, foot progression angle (FPA) has emerged as an important determinant of dynamic knee loading. Altered FPA may modify tibiofemoral joint stress distribution, thereby contributing to pain progression and functional deterioration.^{7,8}

Psychological factors, including anxiety, depression, and impaired resilience, have also been implicated in chronic pain amplification, central sensitization, and poorer rehabilitation outcomes in osteoarthritis populations.^{9,10}

Despite growing evidence supporting a biopsychosocial model of KOA, the combined influence of age, gait biomechanics, and psychological distress on WOMAC outcomes remains insufficiently explored. Therefore, the present study aimed to evaluate the interrelationship of age, foot progression angle, and psychological distress with functional disability in patients with knee osteoarthritis.

METHODS

This cross-sectional observational study was conducted between January 2024 and February 2025 in the Department of Orthopedics at AIIMS Rishikesh, a tertiary care hospital. A total of 108 patients aged 45–70 years with unilateral or bilateral knee osteoarthritis were recruited from the outpatient department after obtaining written informed consent.

Inclusion criteria comprised patients within the specified age range, a clinical diagnosis of knee osteoarthritis, and radiographic evidence of Grade II or Grade III disease according to the Kellgren–Lawrence grading system.

Patients with inflammatory arthritis, neurological disorders affecting gait, recent lower limb surgery, prior joint replacement, or those using assistive ambulatory devices were excluded. Sample size estimation was based on a correlation analysis, with 80% power and a 5% significance level. Demographic and clinical variables, including age, sex, body mass index (BMI), symptom duration, and comorbidities, were recorded.

Functional disability was assessed using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC modified CRD Pune version), psychological distress was evaluated using the Patient Health Questionnaire-9 (PHQ-9) and the Generalized Anxiety Disorder-7 (GAD-7), and resilience was measured using

the Brief Resilience Scale (BRS). Foot progression angle was determined during a standardized gait assessment.

Statistical analysis

Statistical analysis was performed using SPSS version 17.0. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequencies and percentages. Pearson correlation analysis was used to assess associations between WOMAC scores and age, foot progression angle, depression, anxiety, and resilience. Multivariate linear regression analysis was performed to identify independent predictors of WOMAC outcome. Regression coefficients were expressed with 95% confidence intervals (CI). A $p < 0.05$ was considered statistically significant.

RESULTS

A total of 108 patients were included in the study. The mean age was 50.5 ± 6.8 years, and the mean BMI was 27.1 ± 4.3 kg/m². The majority of patients demonstrated KL Grade III osteoarthritis. Advancing age and abnormal foot progression angle were associated with worsening WOMAC scores. Depression and anxiety demonstrated weak positive correlations with WOMAC outcomes, whereas resilience exhibited an inverse relationship. Multivariate regression analysis demonstrated that foot progression angle and psychological distress independently contributed to the WOMAC outcome after adjustment for age and BMI.

Table 1: Demographic and clinical characteristics of study participants (n=108).

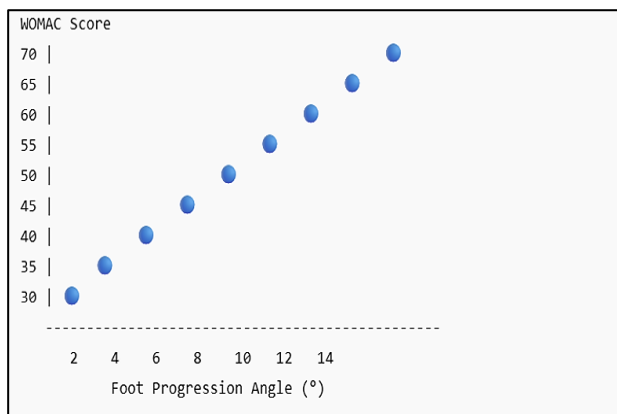
Parameter	Value
Age (years)	50.5 $\pm$ 6.8
BMI (kg/m ²)	27.1 $\pm$ 4.3
Female	75 (69.4%)
Male	33 (30.6%)
KL grade II	46 (42.6%)
KL grade III	62 (57.4%)
Foot progression angle (°)	9.8 $\pm$ 3.2

Table 2: Correlation of biomechanical and psychological variables with WOMAC outcome.

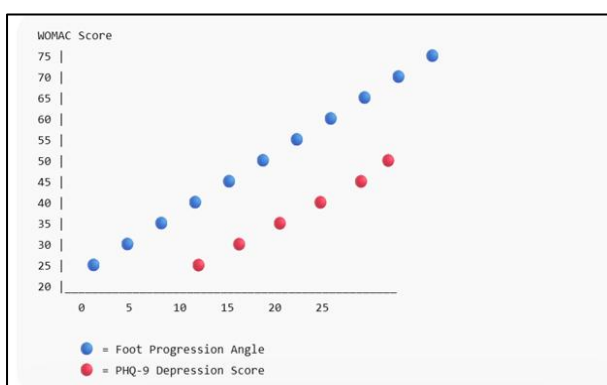
Variables	Correlation coefficient (r)	R ² value	Exact p value
Age (years)	0.24	0.05	0.021
Foot progression angle	0.41	0.17	0.0003
PHQ-9	0.19	0.08	0.048
GAD-7	0.21	0.09	0.031
Resilience score	-0.18	0.03	0.072

Table 3: Multivariate linear regression analysis predicting WOMAC outcome.

Variables	β coefficient	95% CI	P value
Age (years)	0.18	0.02 to 0.34	0.041
Foot progression angle	0.41	0.24 to 0.58	0.0002
PHQ-9	0.22	0.01 to 0.43	0.034
GAD-7	0.19	0.02 to 0.36	0.038
Resilience score	-0.16	-0.34 to 0.02	0.081

**Figure 1: Association between foot progression angle and WOMAC score.**

Scatter plot demonstrating a positive association between increasing foot progression angle and worsening functional disability measured using the WOMAC score in patients with knee osteoarthritis.

**Figure 2: Correlation of biomechanical and psychological variables with WOMAC outcome.**

DISCUSSION

The present study demonstrates that functional disability in knee osteoarthritis is influenced not only by radiographic disease severity but also by biomechanical

and psychosocial determinants. The observed association between altered foot progression angle and WOMAC outcome highlights the importance of gait biomechanics in mediating joint loading and symptom severity. An altered foot progression angle may increase medial tibiofemoral loading, thereby increasing joint compression forces and accelerating functional deterioration, consistent with prior biomechanical studies identifying gait mechanics as a major contributor to progressive limitation in KOA.^{11,12} Notably, gait retraining interventions have been shown to reduce medial compartment loading and improve pain outcomes, underscoring the clinical relevance of biomechanical assessment.¹¹

Concurrent psychological distress may influence pain perception through central sensitization pathways, altered neuromuscular control, fear-avoidant behavior, and maladaptive coping strategies. Previous studies have similarly reported that anxiety and depression are prevalent in osteoarthritis populations and are associated with poorer rehabilitation outcomes.¹³ The inverse relationship between resilience and WOMAC outcome observed in this study suggests that psychological adaptability may protect against disability progression, aligning with emerging evidence that resilience contributes to improved coping and functional independence in musculoskeletal conditions.¹⁴

These findings suggest that incorporating gait assessment and psychological screening into routine osteoarthritis rehabilitation may facilitate earlier identification of high-risk functional phenotypes and support personalized, multidisciplinary intervention strategies. Collectively, these results reinforce the growing emphasis on a biopsychosocial framework in osteoarthritis rehabilitation, supporting the integration of biomechanical and psychological assessment into routine clinical management.^{13,14} Such an approach is consistent with contemporary osteoarthritis management guidelines that advocate multimodal interventions combining exercise therapy, psychological support, and lifestyle modification.¹⁵

Limitations

The cross-sectional design limits causal inference. Foot progression angle was assessed clinically rather than using advanced three-dimensional gait analysis systems. Psychological variables were assessed using self-report questionnaires, which may introduce reporting bias. Additionally, the modest strength of the correlation among psychological variables suggests the possibility of residual confounding. Future longitudinal studies with larger cohorts and objective biomechanical assessment are warranted.

CONCLUSION

Functional disability in knee osteoarthritis extends beyond radiographic severity and appears to be significantly

influenced by age, gait biomechanics, and psychological distress. Integrating biomechanical assessment and psychological screening into routine clinical evaluation may improve individualized rehabilitation strategies and optimize long-term functional outcomes.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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