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Original Research Article

Occupational mechanical load and severity of knee osteoarthritis: a cross-sectional analysis

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ABSTRACT

Background: Knee osteoarthritis (OA) is a leading cause of pain and disability worldwide. While occupational physical activity is recognized as a risk factor for knee OA, limited evidence exists on how specific occupational mechanical loads independently influence disease severity. This study aimed to evaluate the association between cumulative occupational mechanical load and severity of knee OA using WOMAC-based outcomes. The objective of the study was to identify independent occupational mechanical load factors associated with increased severity of knee OA using WOMAC-based regression analysis.
Methods: A hospital-based cross-sectional study was conducted among 200 patients with clinically and radiologically confirmed knee OA at a tertiary care center in Bangladesh. Disease severity was categorized using total WOMAC score into low, moderate, and severe groups. Univariate and multivariate logistic regression analyses were performed to identify independent predictors of increased OA severity.
Results: The majority of patients had moderate (70%) or severe (26%) WOMAC scores. On univariate analysis, increasing age, rural residence, prolonged exposure to squatting and lifting weight, higher daily walking distance. In multivariate analysis, increasing age (adjusted OR 1.18, $p<0.001$), longer duration of occupational squatting (adjusted OR 1.08 per year, $p=0.001$), and higher daily walking distance (adjusted OR 1.30 per mile/day, $p=0.017$) remained independent predictors of disease severity.
Conclusion: Cumulative occupational mechanical load plays a significant role in determining the severity of knee osteoarthritis. Prolonged squatting and high daily walking exposure emerged as key independent occupational predictors, highlighting the importance of early occupational risk identification and targeted preventive interventions.

Keywords: Knee osteoarthritis, Occupational mechanical load, WOMAC score, Disease severity, Squatting

INTRODUCTION

Knee osteoarthritis (OA) is one of the most prevalent chronic musculoskeletal disorders and a major cause of pain, functional limitation, and disability among adults worldwide. It represents a significant public health burden due to its progressive nature, impact on quality of life, and rising healthcare costs. Globally, knee OA contributes substantially to years lived with disability, particularly among older adults and populations engaged in physically demanding work.[1,2] With increasing life expectancy and continued exposure to occupational mechanical stress, the prevalence of knee OA is expected to rise further in low- and middle-income countries. Osteoarthritis is a multifactorial disease characterized by degeneration of articular cartilage, subchondral bone remodeling, synovial inflammation, and periarticular muscle weakness. While aging is a well-established non-modifiable risk factor, mechanical loading of the knee joint plays a critical role in both the initiation and progression of the disease.[3] Repetitive joint stress alters cartilage metabolism and accelerates structural damage, leading to worsening pain and functional impairment over time. Occupational activities involving prolonged standing, walking, squatting, kneeling, stair climbing, and heavy lifting have been consistently implicated as important contributors to knee OA. Epidemiological studies from different regions have demonstrated higher prevalence and severity of knee OA among individuals engaged in manual labor, farming, construction work, and other physically demanding occupations.[4-6] Activities that require frequent knee bending or sustained load transmission through the joint are particularly harmful, as they increase compressive forces across the tibiofemoral compartment. Several studies have examined occupational exposure as a risk factor for the development of knee OA; however, fewer studies have focused on how cumulative occupational mechanical load influences disease severity once OA has developed. Most existing literature emphasizes disease occurrence rather than functional severity, and many studies rely solely on radiographic findings, which may not correlate well with patient-reported symptoms.[7] This highlights the importance of incorporating validated clinical outcome measures when assessing disease severity. The Western Ontario and McMaster Universities osteoarthritis index (WOMAC) is a widely used, validated tool that assesses pain, stiffness, and physical function in patients with knee OA. WOMAC scores provide a comprehensive assessment of disease severity from the patient's perspective and have been shown to correlate with functional limitation and quality of life. Using WOMAC-based severity categories allows for a more meaningful evaluation of how occupational exposures affect clinical outcomes. In Bangladesh and other South Asian countries, a large proportion of the adult population is engaged in occupations involving repetitive knee-loading activities, often beginning at a young age and continuing for decades. Despite this, there is limited local evidence examining the relationship between lifetime occupational mechanical load and severity of knee OA. Understanding these associations is essential for early risk identification, preventive strategies, and workplace modifications aimed at reducing disease progression.[9] Therefore, this study was conducted to evaluate the association between cumulative occupational mechanical load and the severity of knee osteoarthritis among adult patients attending a tertiary care hospital in Bangladesh. By analyzing specific occupational activities and their duration and intensity in relation to WOMAC-based severity, this study aims to identify independent occupational predictors of more severe disease and contribute evidence relevant to clinical management and public health planning.

METHODS

A hospital-based cross-sectional analytical study was conducted in the Department of Medicine Chittagong Medical hospital in Bangladesh. The study was carried out over a six-month August 2019 to January 2020. The study included 200 adult patients diagnosed with knee osteoarthritis who attended the inpatient and outpatient departments of Medicine, Orthopedics, and Physical Medicine. Patients were recruited using purposive sampling due to time and resource constraints. Equal numbers of male and female participants were included to minimize gender-related bias.

Inclusion criteria

Adult patients diagnosed with knee osteoarthritis based on the American College of Rheumatology (ACR) 1991 classification criteria. Radiographic evidence of knee osteoarthritis consistent with clinical findings. Patients presenting with knee pain for at least one month during the preceding year. Patients who provided written informed consent to participate in the study.

Exclusion criteria

Patients with a history of inflammatory arthritis (such as rheumatoid arthritis or gout) were excluded. Individuals with previous knee trauma, fracture, or surgery were not included. Patients with congenital or developmental deformities of the knee joint were excluded. Those with secondary osteoarthritis due to infection, metabolic disorders, or malignancy were also excluded. Patients with severe systemic illness or who were unable to complete the WOMAC questionnaire were not considered for the study.

Data collection procedure

Eligible participants were identified through a screening question regarding knee pain lasting at least one month during the preceding year. Patients fulfilling the screening criteria were assessed using the ACR 1991 diagnostic criteria and radiographic evaluation. Data were collected through face-to-face interviews using a predesigned and pretested questionnaire. Detailed occupational history was

obtained, focusing on lifetime exposure to physically demanding activities.

Statistical analysis

Data were entered into Microsoft Excel and analyzed using statistical package for social sciences (SPSS) version 23. Descriptive statistics were used to summarize demographic, clinical, and occupational variables. Categorical variables were expressed as frequencies and percentages, while continuous variables were presented as mean±standard deviation. Associations between occupational exposures and WOMAC severity were initially explored using chi-square tests, student's t-tests, and one-way ANOVA as appropriate. Odds ratios (ORs) with 95% confidence intervals (CIs) were reported. A $p<0.05$ was considered statistically significant.

Ethical considerations

All participants were informed about the purpose, scope, and voluntary nature of the study. Written informed consent was obtained prior to data collection. Participant confidentiality and anonymity were strictly maintained throughout the study. The study involved no intervention and posed no risk to participants or the environment.

RESULTS

Among the participants, standing was the most common activity (88.0%), followed by walking (76.0%) and squatting (68.0%). The mean duration of exposure ranged from 23 to 35 years across activities. Daily exposure was highest for standing (3.41 hours/day) and sitting (3.13 hours/day). Kneeling was least common (8.0%) but showed the longest mean exposure duration (Table 1).

Most participants had moderate WOMAC scores (70.0%). Severe WOMAC scores were found in 26.0% of cases. Only 4.0% of participants had low disease severity. This indicates that the majority presented with moderate to severe knee osteoarthritis (Table 2).

Longer duration of squatting, kneeling, lifting weight, and stair climbing was associated with higher WOMAC severity ($p\leq0.001$). Mean squatting duration increased from 23.0 years (low) to 30.8 years (severe). Standing, walking, and sitting duration did not show significant differences across severity groups (Table 3).

Increasing age was strongly associated with severe WOMAC score (OR 1.70, $p<0.001$). Rural residence showed higher odds of severe disease (OR 2.12, $p=0.022$). Both duration and dose of squatting and lifting weight significantly increased the odds of severe WOMAC score. Higher walking dose was also significantly associated (Table 4).

After adjustment, age remained a significant predictor (adjusted OR 1.18, $p<0.001$). Longer duration of squatting independently increased disease severity (adjusted OR 1.08, $p=0.001$) (Table 5).

Table 1: Distribution of occupational mechanical load among study participants (n=200).

Occupational activity	Frequency n (%)	Duration of exposure (years), mean±SD	Daily dose of exposure, mean±SD
Standing	176 (88.0)	27.21±8.11	3.41±2.71 hours/day
Walking	152 (76.0)	26.57±7.95	2.55±5.21 miles/day
Sitting	113 (56.5)	30.63±7.36	3.13±2.46 hours/day
Squatting	136 (68.0)	27.21±7.95	1.34±1.53 hours/day
Lifting weight	92 (46.0)	23.18±9.35	2.70±6.42 kg/day
Stair climbing	48 (24.0)	27.42±9.93	73.66±16.64 flights/day
Kneeling	16 (8.0)	35.40±0.52	2.57±1.22 hours/day

Table 2: Distribution of WOMAC severity categories (n=200).

WOMAC severity category	WOMAC score range	Frequency (n)	Percentage (%)
Low	<60	8	4.0
Moderate	60–80	140	70.0
Severe	>80	52	26.0
Total	—	200	100

Table 3: Association between WOMAC severity and duration of occupational exposure (years).

Occupational activity	Low WOMAC mean±SD	Moderate WOMAC mean±SD	Severe WOMAC mean±SD	P value
Standing	25.67±1.56	28.03±7.81	27.44±9.15	0.880
Walking	NA	26.31±8.64	27.44±11.61	0.534
Sitting	NA	28.05±5.66	31.29±7.63	0.065

Continued.

Occupational activity	Low WOMAC mean±SD	Moderate WOMAC mean±SD	Severe WOMAC mean±SD	P value
Squatting	23.00	25.33±6.39	30.80±9.76	0.001
Kneeling	NA	30.31±0.56	34.62±1.38	<0.001
Lifting weight	19.31±3.34	20.24±7.62	29.20±10.51	<0.001
Stair climbing	NA	19.24±10.26	31.90±6.28	<0.001

Table 4: Univariate logistic regression analysis of factors associated with severe WOMAC score.

Variables	Odds ratio (OR)	95% CI	P value
Age (years)	1.703	1.034–1.113	<0.001
Male sex	0.625	0.329–1.186	0.150
Rural residence	2.116	1.114–4.019	0.022
Lifting weight (duration)	1.115	1.045–1.088	0.023
Lifting weight (dose)	1.124	1.016–1.245	0.025
Squatting (duration)	1.094	1.039–1.152	0.001
Squatting (dose)	1.758	1.268–2.438	0.001
Walking (dose)	1.092	1.016–1.174	0.016
Stair climbing (duration)	0.828	0.743–0.923	0.001
Sitting (dose)	0.845	0.714–0.999	0.049

Table 5: Multivariate logistic regression analysis of independent predictors of WOMAC severity.

Variable	Adjusted OR	95% CI	P value
Age (years)	1.18	1.080–1.289	<0.001
Rural residence	1.598	1.153–2.343	0.461
Squatting (duration, years)	1.083	1.009–1.163	0.001
Squatting (dose, hours/day)	2.898	0.996–1.355	0.056
Walking (dose, miles/day)	1.302	1.049–1.617	0.017
Lifting weight (duration)	1.053	0.985–1.126	0.132
Stair climbing (duration)	0.803	0.722–0.894	0.056

DISCUSSION

The results of this study demonstrate a significant association between specific occupational mechanical loads and the severity of knee OA, with key risk factors identified through regression analyses. This cross-sectional study, conducted in Bangladesh, utilized the WOMAC to assess the severity of knee OA and explored how various occupational activities contribute to disease severity. The findings highlight several important occupational factors, including squatting, walking, and lifting weight, that independently predict OA severity. The demographic and clinical data indicate that the majority of participants (70%) had moderate knee OA severity, while 26% had severe disease. These findings are consistent with global estimates on the prevalence of knee OA, as highlighted by Cross et al, who reported that knee OA is a leading cause of disability worldwide, with most patients experiencing moderate to severe levels of the disease.[1] Our study's results align with similar studies in which moderate OA was the most common severity stage among patients. The study also found that specific occupational activities, such as squatting, walking, and lifting weight, were associated with increased severity of knee OA. As demonstrated, longer exposure to squatting and kneeling was significantly correlated with higher WOMAC scores, with a $p<0.001$ for squatting and kneeling, suggesting a strong relationship between these activities and knee OA severity. These findings are in line with research by Jensen, who found that work involving prolonged squatting or kneeling significantly increased the risk of knee OA.[6] The mechanical load placed on the knee joint during these activities is known to exacerbate the degeneration of cartilage and increase the risk of joint inflammation. The univariate logistic regression analysis, revealing that factors such as age, rural residence, and duration and dose of squatting and lifting weight were significantly associated with severe knee OA. Specifically, increasing age (OR 1.70, $p<0.001$) and rural residence (OR 2.12, $p=0.022$) were identified as key predictors of severe OA. The association between age and OA severity has been well-documented in the literature. Felson et al and McAlindon et al both reported that age is a significant risk factor for knee OA due to the natural wear and tear of the joint over time.[3,9] Moreover, the increased risk for those living in rural areas may be linked to the higher prevalence of physically demanding occupations, as suggested by Jordan et al.[10] In terms of occupational exposures, squatting was found to be a significant predictor of severe OA. The multivariate regression analysis showed that prolonged exposure to squatting independently increased disease severity, with an adjusted odds ratio of 1.08

(p=0.001). This result is consistent with studies by Palmer and Coggon et al, who demonstrated that prolonged squatting leads to a mechanical load that accelerates joint deterioration.[5,11] Squatting requires deep knee flexion, which places substantial stress on the knee joint, potentially leading to cartilage damage over time. Similarly, prolonged walking (adjusted OR 1.30 per mile/day, p=0.017) was found to independently predict knee OA severity, a finding that mirrors the results of Seidler et al, who reported that long periods of walking or standing are also associated with an increased risk of knee OA.[12] The study also highlighted the importance of lifting weight as an occupational risk factor for knee OA. Both the duration and dose of lifting weight were found to significantly increase the odds of severe OA (OR 1.115 and OR 1.124, respectively). Lifting weight places considerable strain on the knee joints, especially when done frequently or with high loads, as shown by Gouttebarge and McWilliams et al.[4,13] These findings support the idea that occupations requiring frequent lifting or carrying heavy loads are linked to higher rates of knee OA, as heavy lifting increases the mechanical forces acting on the knee joint, leading to accelerated cartilage degeneration. Interestingly, the study did not find significant associations between standing and sitting duration and knee OA severity, where standing and sitting activities did not exhibit a statistically significant difference across severity groups. This may seem surprising, given that other studies have linked prolonged standing with knee OA. However, this discrepancy could be explained by variations in the study populations, as certain factors such as body mass index (BMI) and the duration of exposure to these activities may differ between studies. Some studies, such as those by McAlindon et al, suggest that standing, in isolation, may not be as detrimental as activities like squatting or weight lifting that involve higher mechanical loads.[9] The findings of this study reinforce the need for targeted occupational health interventions aimed at reducing mechanical load on the knee joints. Given the independent roles of squatting, walking, and lifting weight in knee OA progression, interventions could focus on modifying work tasks to reduce prolonged squatting and walking, as well as implementing lifting techniques to minimize knee stress. Ergonomic adjustments and the promotion of job rotation are potential strategies that can help mitigate these risks, particularly in high-risk occupations such as construction and agriculture.

CONCLUSION

In conclusion, this study reinforces the significant impact of occupational mechanical load on knee OA severity. Prolonged squatting, walking, and lifting weight were found to be key independent predictors of severe OA. The findings contribute to the growing body of evidence linking occupational physical activity with the progression of knee OA and highlight the need for preventive interventions targeting these specific activities. Further longitudinal studies are needed to confirm the long-term impact of these occupational factors and to explore potential strategies for minimizing knee OA risk in the workplace.

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