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Original Article

A Retrospective Analysis of Occupational Sitting Duration and Early Radiographic Hip Osteoarthritis in Middle-Aged Adults

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ABSTRACT

Background: Prolonged occupational sitting is increasingly common in desk-based work, but its association with early structural hip changes remains insufficiently understood. Objective: To evaluate the association between daily occupational sitting duration and early radiographic hip osteoarthritis among middle-aged adults. Methods: This retrospective observational analytical study included 220 records of adults aged 40–60 years from an industrial and urban region of Punjab, Pakistan. Occupational sitting was categorized as ≤6 or >6 hours/day. Early radiographic hip osteoarthritis was assessed using the Kellgren–Lawrence classification. Categorical associations were examined using the chi-square test, and multivariable logistic regression was used to adjust for age, sex, body mass index, and leisure-time physical activity. Results: The mean age was 51.4 ± 5.8 years, and 135 participants (61.4%) reported occupational sitting >6 hours/day. Early radiographic hip osteoarthritis was present in 51 participants (23.2%), including 11/85 (12.9%) in the ≤6-hour group and 40/135 (29.6%) in the >6-hour group (χ^2=8.16, p=0.004). Prolonged occupational sitting remained associated with greater odds of early radiographic hip osteoarthritis after adjustment (AOR=2.58; 95% CI: 1.24–5.37; p=0.011). Conclusion: Occupational sitting exceeding 6 hours/day was independently associated with greater odds of early radiographic hip osteoarthritis, although the retrospective observational design does not establish causality. Keywords: Adult; Hip Osteoarthritis; Occupational Health; Radiography; Sedentary Behavior.

INTRODUCTION

The increasing transition from physically demanding occupations to desk-based and computer-dependent work has substantially changed patterns of physical activity during the working day. Prolonged sitting is now common in many professional, administrative, and clerical occupations and has become an important occupational-health

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concern because sustained sedentary work may contribute to musculoskeletal symptoms and disorders (1). Osteoarthritis is among the major musculoskeletal conditions associated with pain, impaired mobility, work limitation, and reduced functional capacity, creating an important burden for individuals who remain economically active during middle age (2). Although age, obesity, previous joint injury, structural abnormalities, and mechanical loading are established contributors to osteoarthritis, the influence of prolonged occupational sedentary exposure on structural changes in weight-bearing joints remains less clearly defined.

The hip is a major weight-bearing joint whose structural health is influenced by the magnitude, distribution, and frequency of mechanical loading. Physical activity and movement are relevant to the clinical course and management of hip and knee osteoarthritis, whereas prolonged periods of limited movement represent a substantially different mechanical environment (3). Experimental and clinical concepts concerning joint loading suggest that both excessive loading and insufficient or poorly distributed loading may adversely affect joint health, supporting the concept of an optimal range of mechanical stimulus for maintaining cartilage and periarticular tissues (4). However, much of the available evidence regarding mechanical exposure and osteoarthritis has focused on sports participation, repetitive high-load activities, or physically demanding occupations rather than sustained occupational sitting (5). Consequently, the implications of prolonged desk-based work for early hip structural abnormalities remain uncertain.

This uncertainty is particularly relevant among adults aged 40–60 years, in whom early degenerative changes may develop while individuals are still actively employed. Previous occupational research has examined mechanical risk factors for hip symptoms and non-arthritic hip disorders, demonstrating that workplace exposures can be relevant to hip health (6). Nevertheless, evidence specifically isolating daily occupational sitting duration from other physical and occupational exposures is limited. Sitting duration may also coexist with other determinants of osteoarthritis, including age, body mass index, sex, and physical activity outside working hours. These factors make it important to evaluate the association between occupational sitting and hip abnormalities using an analytical approach that accounts for major potential confounders rather than interpreting sedentary exposure in isolation.

Radiographic assessment provides an objective method for identifying structural features of osteoarthritis and can complement symptom-based evaluation. Imaging-based approaches have an established role in osteoarthritis research because structural abnormalities may be identified independently of self-reported pain or functional limitation (7). In epidemiological research, the Kellgren–Lawrence grading system is commonly used to categorize radiographic osteoarthritic changes according to features such as osteophyte formation and joint-space narrowing. For the present study, radiographic classification therefore provides a clinically relevant outcome with which to examine whether different levels of documented occupational sitting are associated with early structural hip changes.

Despite the occupational relevance of prolonged sedentary work, the existing literature represented in this manuscript provides limited direct evidence regarding the relationship between daily workplace sitting duration and early radiographic hip osteoarthritis in middle-aged adults. In particular, there remains uncertainty as to whether individuals with prolonged occupational sitting have a greater prevalence of early radiographic hip osteoarthritis than those with shorter daily sitting duration after accounting for important demographic, anthropometric, and lifestyle factors. Addressing this question may help clarify whether occupational sitting warrants further investigation as a potentially modifiable exposure in prospective studies of hip health. Therefore, this retrospective observational analysis aimed to evaluate the association between occupational sitting duration and the presence of early radiographic hip osteoarthritis among adults aged 40–60 years and to determine whether prolonged occupational sitting remained associated with radiographic osteoarthritis after adjustment for age, sex, body mass index, and leisure-time physical activity.

MATERIAL AND METHODS

A retrospective observational analytical study was conducted to examine the association between occupational sitting duration and early radiographic hip osteoarthritis among middle-aged adults. The analysis was based on existing medical records, occupational information documented within electronic health records, and archived radiographic data from patients evaluated within the industrial and urban region of Punjab, Pakistan. The retrospective review covered records generated from January 2021 through December 2023, while data extraction, cleaning, verification, and statistical analysis were completed over an eight-month period. This design was selected

to permit evaluation of documented occupational exposure in relation to objectively assessed radiographic hip changes without direct participant contact.

The target population comprised adults aged 40–60 years who had undergone pelvic or hip radiographic imaging during the study period and whose medical records contained sufficient occupational information for assessment of daily workplace sitting. Eligible records were required to document employment in a professional or clerical occupation with quantifiable daily sitting duration for at least the preceding five years and to include complete bilateral hip radiographs with corresponding clinical documentation. Records were excluded when participants had a history of previous hip surgery, acute high-energy lower-extremity trauma, congenital or developmental hip dysplasia, inflammatory arthropathy including rheumatoid arthritis, avascular necrosis of the femoral head, or a body mass index greater than 35 kg/m^2. Records lacking information on the primary exposure or primary radiographic outcome were excluded from the analytical cohort. Because the investigation used previously recorded clinical and radiographic information, no direct patient recruitment or study-specific participant contact was undertaken.

The required sample size was estimated using an anticipated prevalence of early radiographic hip osteoarthritis of 15%, a 95% confidence level, and a 5% margin of error, which yielded a minimum required sample of 196 participants. To accommodate incomplete secondary covariate information and improve the analytical dataset, 220 complete eligible patient records were included in the final analysis. Selection was restricted to records meeting the predefined eligibility criteria and containing sufficiently documented occupational exposure and radiographic information for the primary analysis.

Data were extracted by trained medical reviewers using a structured data-extraction proforma to promote consistency across records. Information was obtained from digitized hospital charts, occupational-health information contained within electronic medical records, and digital radiographic archives. Demographic and clinical variables included age, sex, body mass index, and leisure-time physical activity. Physical activity was recorded as metabolic equivalent task minutes per week when documented in the source records. Occupational sitting duration constituted the principal exposure and was derived from documented self-reported occupational history or available workplace assessment information. Participants were categorized as having occupational sitting of ≤6 hours per working day or prolonged occupational sitting of >6 hours per working day.

The primary outcome was the presence of early radiographic hip osteoarthritis. Radiographic assessment was based on weight-bearing anteroposterior pelvic radiographs and classified using the Kellgren–Lawrence grading system. Early radiographic osteoarthritis was defined in the study dataset as Kellgren–Lawrence grade 2, characterized by definite osteophyte formation with possible joint-space narrowing, whereas grades 0 and 1 were classified as no or doubtful radiographic osteoarthritis. Complete bilateral hip radiographs were required for inclusion. Radiographs were independently reviewed by two musculoskeletal radiologists who were blinded to the occupational exposure classification, and disagreements in radiographic interpretation were resolved through review by a senior consultant. This procedure was used to reduce observer-related classification bias in assessment of the primary outcome.

Age, sex, body mass index, and leisure-time physical activity were treated as potential confounding variables because of their possible relationships with osteoarthritis and patterns of physical activity. Measures intended to reduce information and selection bias included use of predefined eligibility criteria, standardized digital radiographs, structured extraction procedures, standardized occupational descriptions where available, and blinded radiographic assessment. Records with missing information on occupational sitting duration or radiographic osteoarthritis status were excluded before analysis. Minor missing values in secondary covariates were handled using complete-case, or listwise, analysis for the relevant multivariable model so that regression estimates were based only on records containing the variables required for adjustment.

Statistical analysis was performed using IBM SPSS Statistics version 26.0. Continuous demographic and anthropometric variables were summarized using means and standard deviations, whereas categorical variables were reported as frequencies and percentages. The unadjusted association between occupational sitting category and the presence of early radiographic hip osteoarthritis was examined using the chi-square test. Binary logistic regression was subsequently performed with radiographic hip osteoarthritis status as the dependent variable and occupational sitting category as the principal independent variable. The adjusted model included age, sex, body

mass index, and leisure-time physical activity as covariates. Adjusted odds ratios with corresponding 95% confidence intervals were calculated to quantify the association between prolonged occupational sitting and early radiographic hip osteoarthritis after controlling for these potential confounders. All statistical tests were two-tailed, and statistical significance was defined as a p-value ≤0.05.

Patient confidentiality was maintained throughout data extraction and analysis. Personal identifiers, including names and national identification information, were removed during extraction and replaced with anonymized alphanumeric codes. The analytical dataset was stored on a password-protected system with access restricted to the investigative team. No direct patient contact occurred as part of this retrospective record-based investigation.

RESULTS

A total of 220 participant records were included in the final analysis. The mean age was 51.4 ± 5.8 years, and the study population included 119 males (54.1%) and 101 females (45.9%). Mean body mass index was 27.2 ± 3.4 kg/m^2, while mean leisure-time physical activity was 420.5 ± 185.2 MET-min/week. Occupational sitting exceeding 6 hours per working day was reported for 135 participants (61.4%), whereas 85 participants (38.6%) were classified in the ≤6-hour/day category. Early radiographic hip osteoarthritis was present in 51 participants (23.2%).

Early radiographic hip osteoarthritis was identified in 40 of 135 participants (29.6%) who reported occupational sitting >6 hours/day compared with 11 of 85 participants (12.9%) in the ≤6-hour/day group. The absolute difference in prevalence between the two sitting categories was 16.7 percentage points (95% CI 6.2–27.2). Pearson chi-square analysis demonstrated an association between occupational sitting category and early radiographic hip osteoarthritis, $\chi^2(1)=8.16$, p=0.004. The crude odds of radiographic osteoarthritis were 2.83 times greater in the >6-hour/day group than in the ≤6-hour/day group (OR 2.83, 95% CI 1.36–5.90). The corresponding prevalence ratio was 2.29 (95% CI 1.24–4.21).

Table 1. Demographic and Clinical Characteristics of the Study Population (N = 220)

Variable	Total (N = 220)
Age, years, mean ± SD	51.4 ± 5.8
Male, n (%)	119 (54.1)
Female, n (%)	101 (45.9)
Body mass index, kg/m², mean ± SD	27.2 ± 3.4
Leisure-time physical activity, MET-min/week, mean ± SD	420.5 ± 185.2
Occupational sitting ≤6 h/day, n (%)	85 (38.6)
Occupational sitting >6 h/day, n (%)	135 (61.4)
Early radiographic hip osteoarthritis, n (%)	51 (23.2)

Abbreviations: SD, standard deviation; MET, metabolic equivalent task.

Table 2. Association Between Occupational Sitting Duration and Early Radiographic Hip Osteoarthritis

Occupational sitting duration	Early radiographic OA, n (%)	No/doubtful radiographic OA, n (%)	Total, n	Crude OR (95% CI)	Prevalence ratio (95% CI)	Prevalence difference, % (95% CI)	χ^2	p-value
≤6 h/day	11 (12.9)	74 (87.1)	85	1.00	1.00	0.0		
>6 h/day	40 (29.6)	95 (70.4)	135	2.83 (1.36–5.90)	2.29 (1.24–4.21)	16.7 (6.2–27.2)	8.16	0.004

Abbreviations: OA, osteoarthritis; OR, odds ratio; CI, confidence interval. The ≤6 h/day group was the reference category. Pearson chi-square test was used for the categorical association. Crude OR, prevalence ratio, prevalence difference, and their 95% CIs were derived from the reported complete 2×2 cell counts.

Table 3. Multivariable Logistic Regression for Early Radiographic Hip Osteoarthritis

Variable	Adjusted OR	95% CI	p-value
Occupational sitting ≤6 h/day	1.00	—	—
Occupational sitting >6 h/day	2.58	1.24–5.37	0.011
Age, per 1-year increase	1.08	1.01–1.16	0.031
Body mass index, per 1 kg/m² increase	1.12	1.00–1.25	0.042
Leisure-time physical activity	0.99	0.98–1.01	0.415

Abbreviations: OR, odds ratio; CI, confidence interval. The multivariable model was reported as adjusted for occupational sitting duration, age, sex, body mass index, and leisure-time physical activity. Sex was included in the

reported adjustment set but is not displayed because its coefficient, adjusted OR, confidence interval, and exact p-value were not provided in the available statistical results.

In the multivariable logistic regression model adjusted for age, sex, body mass index, and leisure-time physical activity, occupational sitting >6 hours/day remained associated with greater odds of early radiographic hip osteoarthritis compared with sitting ≤6 hours/day (adjusted OR 2.58, 95% CI 1.24–5.37; p=0.011). Increasing age was also associated with the outcome (adjusted OR 1.08 per year, 95% CI 1.01–1.16; p=0.031), corresponding to an approximately 8% increase in the adjusted odds per additional year of age. Body mass index showed a smaller positive association (adjusted OR 1.12 per kg/m^2, 95% CI 1.00–1.25; p=0.042). Leisure-time physical activity was not statistically associated with radiographic osteoarthritis in the adjusted model (adjusted OR 0.99, 95% CI 0.98–1.01; p=0.415).

DISCUSSION

The present study found that prolonged occupational sitting was associated with a greater prevalence of early radiographic hip osteoarthritis among middle-aged adults. This association remained after adjustment for age, sex, body mass index, and leisure-time physical activity, indicating that the relationship was not explained entirely by these measured covariates. The findings therefore support the study objective by identifying an independent statistical association between longer daily occupational sitting and early radiographic hip osteoarthritis, while the retrospective observational design does not permit conclusions regarding causality or temporal progression.

The findings are relevant within the broader context of occupational musculoskeletal health. Work-related musculoskeletal disorders are influenced by a range of occupational exposures, including prolonged static postures and limited movement during the working day (1). Although much of the existing occupational literature has focused on pain, functional complaints, or physically demanding work, the current findings extend this discussion to an objectively assessed radiographic hip outcome. Previous work examining occupational risk factors for hip disorders has demonstrated that workplace mechanical exposures may be relevant to hip health, although such evidence has largely concerned non-arthritic hip pain or other occupational loading patterns rather than prolonged sitting specifically (6). The present results therefore suggest that sedentary occupational exposure may warrant further investigation alongside more traditionally recognized mechanical risk factors.

A possible explanation for the observed association relates to the broader concept that joint tissues respond to both the magnitude and pattern of mechanical loading. Experimental and clinical literature suggests that joint health may be influenced by an optimal range of mechanical loading, with both excessive loading and insufficient dynamic loading potentially affecting cartilage and periarticular tissues (4). Prolonged sitting differs from ambulatory activity in that the hip remains relatively static and flexed for extended periods, reducing the frequency of cyclical loading and movement. However, these mechanisms were not directly measured in the present study and should therefore be considered biologically plausible explanations rather than demonstrated pathways. Similarly, evidence from sports-related osteoarthritis research indicates that repetitive mechanical exposure may influence long-term joint health, but the type, intensity, and direction of loading in athletic activity differ substantially from those associated with sedentary office work (7).

The persistence of the occupational sitting association after adjustment for body mass index is also noteworthy because excess body mass is an established contributor to the mechanical and metabolic burden of osteoarthritis. In the present analysis, increasing body mass index was itself associated with greater adjusted odds of early radiographic hip osteoarthritis, suggesting that body composition and occupational sitting may represent separate, although potentially interacting, dimensions of musculoskeletal risk. Age also remained associated with the radiographic outcome, which is consistent with the recognized increase in osteoarthritic structural changes with advancing age. These observations support the importance of considering occupational sitting within a broader multifactorial framework rather than treating sedentary behavior as an isolated determinant of hip osteoarthritis (8).

Leisure-time physical activity was not statistically associated with early radiographic hip osteoarthritis in the adjusted model. This finding should not be interpreted as evidence that physical activity is ineffective for joint health or that exercise cannot offset the consequences of occupational sitting. Physical activity remains relevant to the management and functional health of individuals with hip and knee osteoarthritis (9). The absence of a

statistically significant association in the present analysis may reflect limitations in the precision and completeness of retrospectively documented physical activity data, differences in activity type and intensity, or insufficient ability of the available measure to capture patterns of movement across the entire day. Prospective studies using objective activity monitoring would be better suited to determine whether leisure-time exercise modifies the relationship between occupational sitting and structural hip outcomes (10).

The use of radiographic assessment represents an important strength because the primary outcome was based on structural imaging rather than self-reported pain alone. Radiographic assessment can provide objective evidence of osteoarthritic structural change and is commonly incorporated into epidemiological studies of joint disease (11). The independent review of radiographs by two blinded musculoskeletal radiologists, with disagreements resolved through senior review, also reduced the likelihood that occupational exposure status influenced radiographic classification. In addition, adjustment for age, sex, body mass index, and leisure-time physical activity allowed the principal association to be examined while accounting for several important, measured confounders (12,13).

Several limitations must nevertheless be considered when interpreting the findings. First, the retrospective design limits the ability to establish the temporal sequence between prolonged occupational sitting and radiographic osteoarthritis. Sitting duration was derived from information already contained in medical or occupational records and may therefore have been affected by incomplete documentation or exposure misclassification. The classification of sitting into only two categories also reduced information about potential dose-response relationships. Second, inclusion was restricted to individuals who had undergone hip or pelvic radiography, which may have introduced selection or indication bias because this population may differ from asymptomatic workers who had never required imaging. Third, although the adjusted model included several relevant covariates, residual confounding from factors such as previous occupational loading, lifetime physical activity, hip morphology, previous minor injury, metabolic factors, and other unmeasured characteristics cannot be excluded (14,15).

The interpretation of the findings is also limited by the use of a single radiographic assessment rather than longitudinal imaging. Consequently, the study cannot determine whether individuals with prolonged sitting experienced faster progression of osteoarthritis over time. In addition, leisure-time physical activity was based on available record documentation rather than standardized prospective monitoring, and the study did not quantify the frequency of standing breaks or interruptions in occupational sitting. These factors may have resulted in substantial heterogeneity within the exposure categories. Generalizability is also limited because the study population consisted of middle-aged professional and clerical workers from an urban region of Punjab, and the findings may not apply to younger adults, older populations, rural workers, or occupations involving different combinations of sitting, standing, and physical workload (16,17).

From a clinical and occupational-health perspective, the findings identify prolonged workplace sitting as a potentially relevant exposure that merits further investigation rather than establishing a basis for immediate radiographic screening or a specific preventive intervention. Prospective longitudinal studies incorporating objective measurements of sitting, standing, stepping, and movement breaks, together with repeated structural and clinical hip assessments, would help determine whether prolonged occupational sitting precedes the development or progression of hip osteoarthritis. Such research would also clarify whether modifying sedentary work patterns has measurable effects on long-term hip health (18-20).

CONCLUSION

Prolonged occupational sitting of more than 6 hours per day was independently associated with greater odds of early radiographic hip osteoarthritis among middle-aged adults after adjustment for age, sex, body mass index, and leisure-time physical activity. These findings suggest that occupational sitting may be a relevant factor to consider in future research on hip osteoarthritis, although the retrospective observational design does not establish causality or disease progression. Further prospective investigation is required to clarify the temporal relationship between sedentary occupational exposure and structural hip changes.

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