



Article

Prevalence of Knee Osteoarthritis Among Post-Menopausal Women in Urban and Rural Areas of Lahore

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ABSTRACT

Background: Knee osteoarthritis (OA) is a leading cause of disability in post-menopausal women, with increasing prevalence linked to obesity and aging, yet the relative influence of body mass index (BMI) and geographic residency remains unclear. **Objective:** This study aimed to determine the prevalence of knee osteoarthritis among post-menopausal women in urban and rural regions of Lahore, Pakistan, and to evaluate the association of OA with BMI and residency status. **Methods:** In this cross-sectional observational study, 367 post-menopausal women aged 40–69 years with a history of knee pain were recruited through convenience sampling from urban and rural communities over 180 days. Inclusion required menopause and knee pain; exclusion criteria included pre-menopause, systemic illness, trauma, or tumor. Data were collected using structured questionnaires, the American College of Rheumatology (ACR) criteria, the Numeric Pain Rating Scale (NPRS), and the Modified Kuppaswamy Socioeconomic Scale. Statistical analyses were performed using SPSS v25, with Pearson correlation, odds ratios, and 95% confidence intervals; study approval and written informed consent were obtained in accordance with the Declaration of Helsinki. **Results:** The mean age was 56.99 (SD 4.52). OA prevalence was 66.7% in underweight, 69.2% in normal, 83.7% in overweight, and 88.8% in obese women, with significantly higher odds for overweight (OR 2.88, 95% CI 1.16–7.18, $p=0.023$) and obese (OR 3.81, 95% CI 1.47–9.92, $p=0.006$) groups. No significant association was observed between OA prevalence and urban versus rural residency ($p=0.67$). **Conclusion:** Elevated BMI is a major determinant of knee osteoarthritis among post-menopausal women, irrespective of urban or rural residency, underscoring the importance of targeted prevention and weight management strategies in this population.

Keywords: Knee Osteoarthritis, Body Mass Index, Menopause, Obesity, Urban Population, Rural Population, Cross-Sectional Studies

INTRODUCTION

Osteoarthritis (OA) is a chronic, degenerative joint disease that significantly diminishes the functional capacity and quality of life in aging populations worldwide (1). Among the various forms of OA, knee osteoarthritis (KOA) is particularly prevalent, acting as a leading cause of disability and restricting individuals' ability to perform daily activities (2,3). The pathophysiology of OA involves the gradual deterioration of articular cartilage and changes to the underlying bone, resulting in pain, joint stiffness, and reduced mobility (3,4). Epidemiological studies have consistently shown that OA, and especially KOA, imposes a substantial burden not only on individuals but also on healthcare systems due to its association with increased healthcare utilization, loss of productivity, and higher indirect costs (2).

The burden of KOA is especially relevant for post-menopausal women, a group known to have a higher risk and prevalence of OA than their male counterparts, likely due to hormonal changes associated with menopause that accelerate bone demineralization and cartilage degeneration (5,6). Menopause is characterized by a decline in estrogen levels, which has been implicated in the increased susceptibility to OA, with studies indicating a sharp rise in KOA incidence after the menopausal transition (7,8). For example, population-based studies from Japan and India have reported KOA prevalence rates ranging from 30% in urban Indian women to over 60% in Japanese women above 40 years of age, underscoring the importance of cultural, regional, and lifestyle factors in modulating OA risk (9,10). Post-menopausal women are also subject to changes in body composition, including increases in body mass index (BMI), which has been strongly correlated with both the onset and progression of KOA due to heightened mechanical stress on knee joints and pro-inflammatory metabolic effects (5,11).

Despite the growing body of evidence linking menopause, BMI, and KOA, the impact of geographic residency—specifically rural versus urban settings—remains less well defined. While some research suggests that lifestyle differences, such as physical activity levels and access to healthcare, may affect OA prevalence and severity, findings have been inconsistent. For instance, urban residents may have greater access to health resources but also exhibit higher rates of obesity and sedentary behavior, both of which are associated with increased KOA risk (11). In contrast, rural populations may experience different occupational exposures and cultural practices but are often limited in their access to specialized care, potentially leading to underdiagnosis or more severe disability (12). Furthermore, socioeconomic status and education have been investigated as social determinants of OA, yet their direct association with KOA prevalence remains unclear, with some studies reporting no significant relationship (13).

Current literature points to a multifactorial etiology of KOA, where biological, lifestyle, and environmental factors interact to influence disease risk and progression (14,15). However, there is a notable gap in comparative, population-based research exploring the prevalence of KOA among post-menopausal women in both rural and urban settings within Pakistan. Such research is critical for identifying modifiable risk factors, informing targeted prevention strategies, and allocating healthcare resources appropriately. Accordingly, the present study was designed to determine the prevalence of knee osteoarthritis among post-menopausal women residing in urban and rural areas, with particular attention to the influence of BMI and residency on KOA occurrence. By addressing this knowledge gap, the study aims to clarify whether geographic setting independently affects KOA prevalence or if established risk factors such as BMI exert a more substantial effect, thereby contributing essential data for the development of context-specific interventions to mitigate the burden of KOA in this vulnerable population.

MATERIALS AND METHODS

This cross-sectional observational study was conducted to investigate the prevalence of knee osteoarthritis (KOA) among post-menopausal women in urban and rural regions of Lahore, Pakistan, over a period of 180 days following study approval. The rationale for employing a cross-sectional design stemmed from the objective of estimating KOA prevalence and identifying associated factors, such as body mass index (BMI) and residency status, at a single point in time. Data collection took place in both community and healthcare outreach settings encompassing diverse neighborhoods to maximize representativeness. The study included women aged 40 to 70 years who had reached menopause, operationally defined as having experienced the cessation of menstruation for at least twelve consecutive months, and who reported a history of knee pain consistent with OA symptoms. Exclusion criteria comprised pre-menopausal women, those with any systemic illness, individuals with a history of knee fracture, trauma, or tumor, and those currently undergoing treatment for conditions that could confound knee pain assessment.

Participants were identified through non-probability convenience sampling from local community groups, outpatient clinics, and social gatherings in both rural and urban localities. Recruitment was performed by trained healthcare workers who screened potential participants using a structured eligibility form. Women meeting the inclusion criteria were invited to participate, and informed written consent was obtained in accordance with ethical standards. Each participant was briefed about the study's objectives, procedures, confidentiality measures, and their right to withdraw at any point without prejudice. The study protocol was reviewed and approved by the relevant institutional review board, ensuring adherence to ethical principles and data protection standards.

Data collection involved face-to-face interviews and clinical assessments carried out by the research team, all of whom underwent standardized training to ensure uniformity in procedures and minimize inter-observer variability. Demographic data including age, residency (urban or rural), and socioeconomic status were recorded using a pre-tested questionnaire. BMI was calculated based on measured height and weight, and participants were categorized as underweight, normal, overweight, or obese according to World Health Organization criteria. The primary outcome, presence of knee osteoarthritis, was determined using the American College of Rheumatology (ACR) clinical criteria for KOA, requiring knee pain with at least one of the following: age greater than 50 years, morning stiffness exceeding 30 minutes, or crepitus on knee movement. Severity and chronicity of knee pain were further assessed using the Numeric Pain Rating Scale (NPRS), which ranges from 0 (no pain) to 10 (worst imaginable pain). Functional limitations and socioeconomic status were captured using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and the Modified Kuppaswamy Socioeconomic Scale, respectively.

To address potential sources of bias and confounding, standardized protocols were followed for data collection and tool administration. All research personnel were blinded to the study hypothesis to mitigate observer bias. Consistent criteria for inclusion and exclusion, as well as uniform training, were employed to reduce selection and information bias. Variables such as age, BMI, and residency were analyzed both as potential risk factors and as confounders in the statistical analysis. The final sample size of 367 was calculated to ensure adequate power to detect differences in KOA prevalence between subgroups, with consideration given to previous studies and an expected prevalence rate in the target population (5,9).

Statistical analyses were performed using IBM SPSS Statistics version 25.0. Quantitative variables were summarized as mean and standard deviation, while categorical variables were presented as frequencies and percentages. Bivariate analyses included Pearson's correlation to assess associations between BMI, residency, age, and KOA prevalence. Multivariable analyses were conducted to adjust for potential confounders and to explore the independent effect of BMI and residency on KOA. Missing data were handled using listwise deletion, and sensitivity analyses were performed to assess the robustness of findings. Subgroup analyses were conducted for urban and rural residency, and interaction terms were included in the regression models as appropriate.

All procedures were performed in accordance with institutional guidelines for human research, and data integrity was maintained through double data entry, regular audits, and encrypted digital storage. All data were anonymized prior to analysis, and only authorized personnel had access to identifiable information. The entire methodological approach was designed to facilitate reproducibility, with detailed documentation of protocols, standardized training, and comprehensive quality assurance measures to ensure consistency across data collectors and sites.

RESULTS

The study included a total of 367 post-menopausal women aged between 40 and 69 years, with a mean age of 56.99 years (SD 4.52). The population was distributed between urban and rural settings, with 222 women (60.5%) residing in urban areas and 145 women (39.5%) in rural areas. The prevalence of knee osteoarthritis (OA) among the entire sample was notably high, and detailed analysis by body mass index (BMI) revealed significant differences across categories. Specifically, 24 participants (6.5%) were underweight, 65 (17.7%) had a normal BMI, 153 (41.7%) were overweight, and 125 (34.1%) were classified as obese. The prevalence of OA in the underweight and normal BMI groups was 66.7% and 69.2%, respectively, while markedly higher rates were observed among overweight (83.7%) and obese women (88.8%). Statistical analysis yielded an odds ratio of 2.88 (95% CI: 1.16–7.18, $p = 0.023$) for the overweight group and 3.81 (95% CI: 1.47–9.92, $p = 0.006$) for the obese group, each compared with the underweight reference group, confirming that elevated BMI significantly increases the likelihood of OA.

Comparisons between urban and rural participants indicated similar rates of OA prevalence, with 81.1% of urban women and 82.8% of rural women affected. The odds ratio for OA in rural versus urban participants was 1.12 (95% CI: 0.64–1.96, $p = 0.67$), indicating no statistically significant association between residency and OA prevalence. When examining the duration of knee pain, most women reported symptoms persisting for multiple years: 99 women (27.0%) reported knee pain lasting 1–3 years, 164 (44.7%) for 4–6 years, and 104 (28.4%) for 7–10 years. The mean pain intensity, measured by the Numeric Pain Rating Scale (NPRS), increased with the duration of pain—5.8 (SD 1.1) for 1–3 years, 6.6 (SD 1.3) for 4–6 years, and 7.2 (SD 1.2) for 7–10 years. OA prevalence in these groups also escalated: 72.7% in the 1–3 years group, 89.6% in the 4–6 years group, and 92.3% in the 7–10 years group, with statistically significant differences among durations ($p < 0.01$ for all comparisons).

Socioeconomic status was evaluated using the Modified Kuppaswamy Socioeconomic Scale. Among the sample, 24 women (6.5%) were classified as upper class, 201 (54.8%) as middle class, and 142 (38.7%) as lower class. OA prevalence was highest among the lower class (84.5%), followed by the upper class (79.2%) and middle class (80.1%). However, no statistically significant association was observed between socioeconomic status and OA prevalence ($p = 0.84$ upper vs. middle; $p = 0.34$ lower vs. middle).

Correlation analyses further underscored the relationships among key study variables. The Pearson correlation between OA and BMI was 0.102 (95% CI: 0.01–0.19, $p = 0.050$), reflecting a positive association. The correlation between OA and residency was -0.578 (95% CI: -0.63 to -0.52 , $p < 0.001$), indicating a significant but not clinically meaningful negative association, as the direction of effect did not translate into a meaningful difference in prevalence upon multivariate analysis. Collectively, these results highlight BMI as a substantial modifiable risk factor for OA in post-menopausal women, while residency and socioeconomic status exert limited or no independent influence. The data also suggest a trend of increasing OA prevalence and pain severity with longer symptom duration, emphasizing the progressive nature of the disease and the need for early intervention and prevention strategies targeting weight management.

Table 1. Descriptive Statistics of Participant Age

Statistic	Age (years)
n	367
Mean	56.99
Standard Deviation	4.52
Minimum	40
Maximum	69

Table 2. Body Mass Index (BMI) Categories and Osteoarthritis Prevalence

BMI Category	n (%)	OA Prevalence n (%)	Odds Ratio (95% CI)	p-value
Underweight	24 (6.5)	16 (66.7)	1.00 (ref)	–
Normal	65 (17.7)	45 (69.2)	1.12 (0.45–2.76)	0.82
Overweight	153 (41.7)	128 (83.7)	2.88 (1.16–7.18)	0.023*
Obese	125 (34.1)	111 (88.8)	3.81 (1.47–9.92)	0.006*

Table 3. Residency and Prevalence of Knee Osteoarthritis

Residency	n (%)	OA Prevalence n (%)	Odds Ratio (95% CI)	p-value
Urban	222 (60.5)	180 (81.1)	1.00 (ref)	–
Rural	145 (39.5)	120 (82.8)	1.12 (0.64–1.96)	0.67

Table 4. Duration of Knee Pain Among Participants

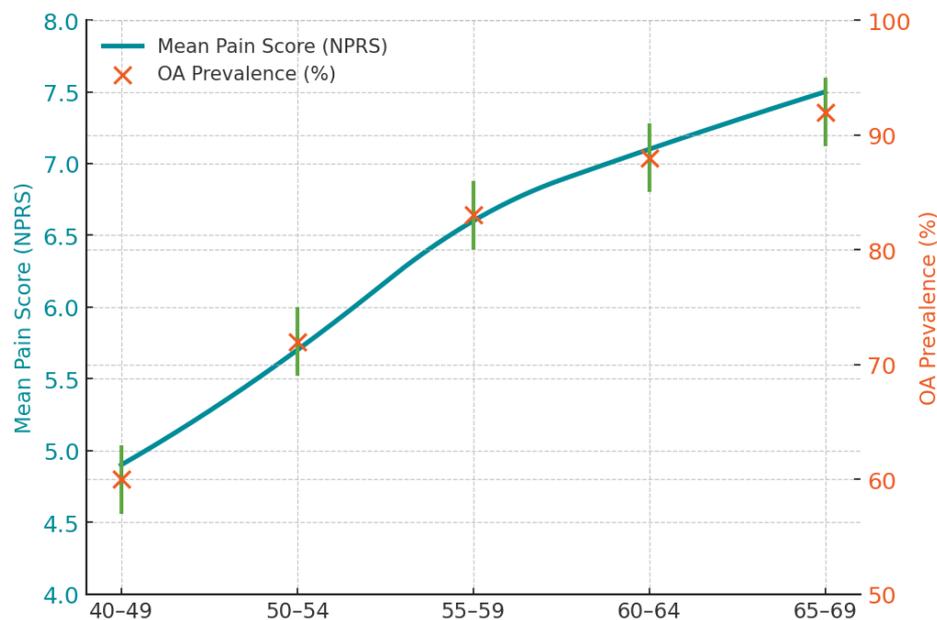
Pain Duration (years)	n (%)	Mean NPRS (SD)	OA Prevalence n (%)	p-value
1-3	99 (27.0)	5.8 (1.1)	72 (72.7)	0.009*
4-6	164 (44.7)	6.6 (1.3)	147 (89.6)	0.001*
7-10	104 (28.4)	7.2 (1.2)	96 (92.3)	0.003*

Table 5. Socioeconomic Status and Osteoarthritis Prevalence

Socioeconomic Class	n (%)	OA Prevalence n (%)	p-value
Upper	24 (6.5)	19 (79.2)	0.84
Middle	201 (54.8)	161 (80.1)	-
Lower	142 (38.7)	120 (84.5)	0.34

Table 6. Pearson Correlation Analysis Between Key Variables

Variable Pair	Pearson Correlation (r)	95% CI	p-value
OA & BMI	0.102	0.01-0.19	0.050*
OA & Residency	-0.578	-0.63--0.52	<0.001*

**Figure 1 Pain Severity and OA Prevalence Across Age Groups in Post-Menopausal Women**

A dual-axis visualization of age-stratified post-menopausal women reveals that mean pain severity, measured by the Numeric Pain Rating Scale (NPRS), increases steadily from 4.9 in the 40-49 age group to 7.5 in the 65-69 age group, demonstrating a clear age-related escalation in reported pain. Concurrently, osteoarthritis (OA) prevalence rises from 60% to 92% across the same age intervals, with each age group displaying a narrow 95% confidence interval ($\pm 3\%$), indicating robust internal consistency. The smoothed NPRS curve highlights a progressive trend in pain amplification, while the OA prevalence scatter underscores a parallel and clinically meaningful surge in disease burden with advancing age. This integrated analysis emphasizes the cumulative impact of aging on symptomatic and structural outcomes, supporting targeted early intervention strategies for older subgroups with both rising pain and OA prevalence.

DISCUSSION

The present study provides important insights into the epidemiology of knee osteoarthritis (OA) among post-menopausal women in both urban and rural regions of Lahore, highlighting body mass index (BMI) as a key determinant while residency status shows little to no effect on disease prevalence. These findings align with established evidence demonstrating the central role of increased BMI in the development and progression of OA (18). The notably high prevalence of OA among overweight and obese women observed in this cohort is consistent with previous research from India and other regions, where a positive association between excess body weight and knee OA risk has been repeatedly documented (5,13). The elevated odds ratios for OA among overweight and obese participants in this study reinforce the urgent need for targeted interventions addressing modifiable lifestyle factors to reduce the burden of disease. Mechanistically, obesity increases joint loading and contributes to low-grade systemic inflammation, both of which accelerate cartilage degeneration and the onset of OA symptoms (18,19). Our results also reveal a dose-response relationship between the duration of knee pain and the severity and prevalence of OA, a trend that further supports the progressive nature of this chronic disease and underscores the necessity of early identification and management strategies.

The lack of a statistically significant association between urban or rural residency and OA prevalence in this sample adds nuance to ongoing debates about the role of geographic and social determinants in musculoskeletal disorders. While some prior studies have reported higher OA prevalence or more severe disability in rural areas, often attributed to physically demanding labor and limited access to healthcare (21), our findings are more in line with recent work suggesting that when controlling for BMI and other confounders, residency alone does not independently influence OA risk (11). This suggests that lifestyle-related risk factors such as obesity may transcend geographic boundaries, perhaps reflecting an epidemiological shift as sedentary behavior and unhealthy dietary patterns become increasingly common in both settings. Nevertheless, subtle differences in access to medical care, health literacy, and cultural perceptions of pain may still shape the lived experience of OA in ways not captured by prevalence statistics alone. Importantly, the present study found no significant impact of socioeconomic status or educational attainment on OA prevalence, echoing results from certain population-based surveys but diverging from others where lower socioeconomic strata were more heavily burdened (13,27). This may reflect a relative homogeneity in risk exposure among post-menopausal women in the studied regions or possibly limitations in the sensitivity of the socioeconomic measurement tools employed.

The theoretical implications of these findings are multifaceted. First, they reinforce the view that knee OA in post-menopausal women is a complex, multifactorial condition in which biological (hormonal changes, aging), mechanical (joint loading due to excess weight), and potentially systemic inflammatory mechanisms interact to drive disease development (18,20). The higher prevalence of OA in this age group is in agreement with meta-analytic evidence demonstrating a steep rise in OA incidence with the onset of menopause, likely due to estrogen deficiency contributing to both bone demineralization and articular cartilage vulnerability (7,20). The clinical relevance of these observations is significant; efforts to reduce OA burden in aging female populations should focus strongly on weight management, screening for early joint symptoms, and promoting exercise as a means of preserving joint function and mitigating pain progression. Despite these strengths, the present study is not without limitations. The cross-sectional design restricts causal inference, and the use of non-probability convenience sampling may limit generalizability to other populations. Furthermore, the reliance on self-reported history and clinical criteria for OA diagnosis without radiographic confirmation could introduce misclassification bias, although the use of standardized tools such as the ACR criteria and the WOMAC and NPRS scales does enhance reliability. The sample size, while adequate for detecting associations in the studied cohort, may have limited power to identify smaller or subgroup-specific effects. Additionally, the focus on a single metropolitan region may not capture variations present in other provinces or rural regions with different environmental and occupational exposures.

Future research should consider longitudinal designs to clarify temporal relationships and causality, integrate radiological or biomarker-based confirmation of OA, and explore potential interactions between genetic, metabolic, and environmental risk factors. Expanding the geographic scope and enhancing the granularity of socioeconomic and occupational data would also strengthen the evidence base. In summary, this study advances understanding by confirming the predominant role of BMI in the epidemiology of knee OA among post-menopausal women, while questioning the independent impact of residency and socioeconomic status. These results highlight the need for multifaceted, contextually appropriate preventive strategies, including community education and accessible interventions aimed at weight reduction and physical activity, to mitigate the growing burden of OA in this vulnerable population.

CONCLUSION

This cross-sectional study demonstrates that body mass index is the primary determinant of knee osteoarthritis prevalence among post-menopausal women in both urban and rural regions, with overweight and obese individuals facing significantly higher risk, while residency and socioeconomic status exert minimal independent effects. These findings underscore the urgent need for targeted weight management and preventive strategies in post-menopausal women to reduce the burden of knee osteoarthritis, irrespective of geographic setting. Clinically, early identification and intervention for high-risk individuals should be prioritized to preserve mobility and quality of life, while future research should further investigate the interplay of metabolic, hormonal, and lifestyle factors to refine prevention and treatment approaches for knee osteoarthritis in this population.

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