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Cultural practices and knee osteoarthritis in Central Asia: a case-control study on risk and protective factors

Almasbek Akhmetov[a], Yerden Khaumet[a], Ikilas Moldaliyev[b], Azamat Seksenbayev, Ainash Oshibayeva[c], Saltanat Kyrykbayeva[d], Gulnaz Nuskabayeva[e] and Akylbek Ibragim[a]

[a]Department of traumatology and orthopedics, clinical and diagnostic center, Akhmet Yassawi International Kazakh-Turkish University, Turkestan, Kazakhstan; [b]Department of public health and scientific research, Akhmet Yassawi International Kazakh-Turkish University, Turkestan, Kazakhstan; [c]Department of preventive medicine, Vice Rector for strategic development, Akhmet Yassawi International Kazakh-Turkish University, Turkestan, Kazakhstan; [d]Center for strategic development, Akhmet Yassawi International Kazakh-Turkish University, Turkestan, Kazakhstan; [e]Department of special clinical disciplines, Akhmet Yassawi International Kazakh-Turkish University, Turkestan, Kazakhstan

ABSTRACT

Introduction: Knee osteoarthritis (KOA) is a degenerative joint disease that leads to pain, stiffness, and disability. While established risk factors such as age, obesity, and joint injury are well-documented, the role of cultural practices remains underexplored. This study investigates the association between traditional cultural practices and KOA prevalence in Central Asia.

Methods: A case-control study was conducted between January and March 2025 in Turkestan, Kazakhstan, involving 337 KOA cases and 685 matched controls. Participants completed structured questionnaires assessing demographic characteristics, lifestyle habits, and cultural practices. Unconditional logistic regression analyses identified associations between cultural factors and KOA, adjusting for age, sex, BMI, education level, physical workload, and type of residence.

Results: Frequent floor sitting (OR = 4.25, 95% CI: 3.02–5.99), squat toilet use (OR = 2.32, 95% CI: 1.66–3.23), and rural residence (OR = 7.57, 95% CI: 4.99–11.48) were strongly associated with KOA. Daily prayer postures did not significantly differ between cases and controls.

Conclusions: Traditional cultural practices involving prolonged knee flexion were associated with KOA. Public health initiatives should consider culturally appropriate strategies that may help mitigate knee strain. Further longitudinal research is needed to establish causality.

PLAIN LANGUAGE SUMMARY

Knee osteoarthritis (KOA) is a common condition that causes knee pain and makes movement difficult, especially for older adults. In Central Asia, many daily activities involve deep knee bending, such as sitting on the floor or using squat toilets. These cultural practices are important in everyday life, but they may place extra stress on the knee joints.

In this study, we compared people diagnosed with KOA to people of similar age and background who did not have the condition. We examined how often they sat on the floor, used squat toilets, worked in physically demanding jobs, or lived in rural areas.

Our results show that people who often sit on the floor, use squat toilets, or do heavy physical work are more likely to have KOA. These activities involve deep and frequent bending of the knees, which may increase strain on the joints over time.

The findings suggest that public health efforts in Central Asia should take local cultural practices into account when planning joint-health programs. Instead of asking people to change long-held traditions, simple steps such as using supportive cushions or modified seating may help reduce knee strain. More long-term research is needed to understand how these practices affect knee health.

ARTICLE HIGHLIGHTS

- Examines cultural practices in Central Asia as potential risk factors for KOA.
- Frequent floor sitting, squat toilet use, and rural lifestyle behaviors show significant associations with KOA.
- Deep knee flexion from these practices may contribute to joint strain over time.
- Case–control comparison of KOA patients and healthy controls from the same region.
- Findings support integrating cultural context into KOA prevention and education efforts.

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Knee osteoarthritis; cultural practices; central Asia; lifestyle risk factors; case-control study

CONTACT Yerden Khaumet yerden.khaumet@ayu.edu.kz Department of traumatology and orthopedics, Clinical and diagnostic center, Akhmet Yassawi International Kazakh-Turkish University, 29 B. Sattarkhanov street, Turkestan161200, Kazakhstan

1. Introduction

Knee osteoarthritis (KOA) is a progressive degenerative joint disease characterized by the breakdown of articular cartilage, subchondral bone remodeling, synovial inflammation, and joint space narrowing [1]. It primarily affects weight-bearing joints, leading to chronic pain, stiffness, swelling, and functional disability [2,3]. As one of the most prevalent forms of arthritis, KOA poses a significant global public health burden, particularly among aging populations [4–6]. KOA has a high prevalence in the elderly as suggested by the Global Burden of Disease study, which estimates symptomatic KOA impacts between 22 and 28% of individuals aged 40 years and above globally, with a greater proportion among females, people living with obesity, and those with a past joint trauma [7].

KOA continues to be a leading source of global disability-adjusted life years (DALY) and healthcare costs despite the development of advances in diagnostic and therapeutic options [8–10]. The condition's significant burden underscores the need to understand its associated factors, including biological, environmental, and sociocultural determinants. While known risk factors such as age, obesity, gender, and joint injury are well-documented, cultural and social influences on the disease remain largely underexplored [11,12]. Evidence from East and South Asia suggests that cultural activities requiring deep knee flexion, such as floor sitting, kneeling, and using squat toilets, may increase mechanical loading on the knee and contribute to KOA [13–18]. However, most of this evidence is derived from non-Central Asian populations and remains inconsistent. These culturally related factors may play an important role in shaping health behaviors, access to care, and treatment adherence, and have been suggested to relate to the onset and progression of KOA [19]. Cultural practices are particularly characteristic of southern Kazakhstan, where the Turkestan region stands out for its higher levels of religiosity and greater preservation of traditional norms [20,21].

Exploring the interplay of cultural influences with KOA is essential for developing effective, context-sensitive prevention and management strategies. Without region-specific evidence, prevention efforts may overlook widespread behaviors that place unique mechanical demands on the knee. Addressing this gap is critical for identifying modifiable cultural and environmental exposures. By situating KOA risk within its cultural context, the present study provides new insights for targeted prevention and clinical guidance. We hypothesized that cultural practices involving prolonged or deep knee flexion would be associated with higher odds of KOA in this population. To our knowledge, this is the first case-control study in Central Asia to investigate cultural practices in relation to KOA. By conducting a case-control study, we aim to identify potential risk factors and protective behaviors associated with these practices.

2. Material and methods

2.1. Study design and setting

This case-control study was conducted in Turkestan city, Kazakhstan, and included participants from the broader Turkestan region, covering both urban and rural areas. The study aimed to explore factors associated with KOA by comparing cases of diagnosed KOA to controls without the condition. The study setting was chosen to ensure representation of diverse sociodemographic, cultural, and lifestyle characteristics in the Turkestan region, facilitating a comprehensive investigation of potential risk factors.

2.2. Participants

The study population comprised two groups: cases with confirmed KOA and frequency matched controls without knee OA. Patients presenting with knee-related complaints completed a questionnaire during their visit. Controls, selected from the Turkestan region, completed the same questionnaire online. Controls were recruited from the general community by distributing a secure online questionnaire link through local social media groups and regional community networks. To prevent contamination of the control sample, the questionnaire included a mandatory item on region of residence, and individuals who reported living outside the Turkestan region were excluded. KOA diagnosis was based on a clinical examination performed by trained physicians, including assessment of knee pain, stiffness, crepitus, and functional limitation, and was confirmed through radiographic evaluation using the Kellgren–Lawrence (KL) grading system. A KL grade of 2 or higher was considered diagnostic of KOA. Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores

were collected to quantify the severity of pain, stiffness, and functional impairment among participants, allowing characterization of symptom burden.

Inclusion criteria for cases included: age 30 years or older, clinically confirmed KOA, and residency in the Turkestan region. Exclusion criteria were any inflammatory arthritis, other joint disorders, and any history of knee replacement or major knee surgeries.

Controls were healthy individuals of age over 30 with no KOA, frequency matched to cases by age, sex, and body mass index (BMI) to minimize confounding. This approach allowed selection from a larger pool of eligible controls, thereby increasing statistical power and avoiding unnecessary loss of participants. Any remaining imbalance in these variables was adjusted for in the final regression model. Individuals with any joint disorders were excluded.

2.3. Data collection

Data was collected between January and March 2025 through structured questionnaires and clinical assessments. The questionnaire captured demographic variables (age, sex, number of births for female participants, family income), lifestyle factors (squatting habits, body weight and height, sports participation, history of trauma), general health information (hypertension, diabetes, previous traumas), and for cases, additional data thorough the WOMAC questionnaire to evaluate pain, stiffness, and functional impairment.

2.4. Sample size calculation

The sample size for this study was determined based on the need to detect significant associations between KOA and cultural activities that involve squatting or kneeling, such as certain prayer practices, dining arrangements, or other traditional postures. Using a conventional formula for unmatched case-control studies and the OpenEpi sample size calculator, we calculated the required number of participants to achieve 80% power at a 5% significance level, assuming an odds ratio of 1.5 for these activities. The expected proportion of controls engaging in these activities was estimated at 40%, based on regional cultural practices and available literature. The calculations indicated that 305 cases and 609 matched controls were necessary to ensure adequate statistical power. To account for potential nonresponse or missing data, we increased the initial sample size by 10%, targeting a total of 1,005 participants. This approach follows standard methodology for case-control studies and ensures sufficient power to detect meaningful associations between these exposures and KOA.

2.5. Ethical considerations

The study protocol was reviewed and approved by the institutional review board. Informed consent was obtained from all participants prior to their inclusion in the study. Confidentiality was maintained by anonymizing data and ensuring that participant information was stored securely.

2.6. Statistical analysis

Descriptive statistics summarized the demographic and lifestyle characteristics of participants. Categorical variables were presented as frequencies and percentages, while continuous variables were expressed as means. Unconditional logistic regression models identified factors associated with KOA, with results reported as odds ratios (ORs) and 95% confidence intervals (CIs). After conducting unadjusted analyses, we constructed a multivariable logistic regression model by entering variables identified a priori as potential confounders of KOA. These included age, sex, BMI, education level, physical workload, and type of residence. These covariates were selected based on established evidence in the KOA literature and their relevance to both cultural practices and KOA prevalence. We also evaluated potential interactions between key demographic and cultural variables to assess effect modification. Model fit was assessed using the Hosmer–Lemeshow goodness-of-fit test. Model specification was evaluated using the link test, and multicollinearity was examined using variance inflation factors (VIF). A p-value of <0.05 was considered statistically significant. Statistical analyses were conducted using Stata 18.0 software.

3. Results

Descriptive statistics for cases and controls are presented in Table 1. Cases were 3.4 years older on average than controls ($p < 0.001$, 95%CI 2.4 to 4.3). No significant differences were observed in the proportion of females ($p = 0.81$) or BMI (mean difference −0.66 kg/m^2, 95%CI −1.38 to 0.07) between the groups.

Several cultural factors showed significant discrepancies. The use of low dinner tables with floor sitting was reported by 73.3% of cases compared to 38.8% of controls ($p < 0.001$). Squat toilets or pit latrines were more common among cases (66.2%) than controls (43.6%) ($p < 0.001$). The proportion of participants performing daily five-time prayers for 10 years or more was higher in cases (19.0%) than in controls (15.6%), but this difference was not statistically significant ($p = 0.17$). The use of traditional cradles (besik) did not differ significantly between groups (52.5% in cases vs. 58.1% in controls, $p = 0.09$).

Significant differences were also observed in socioeconomic status, type of job, and area of residence. Cases were more likely to reside in rural areas (38.3% vs. 8.2%, $p < 0.001$) and to engage in heavy physical work (15.1% vs. 6.9%, $p < 0.001$). The prevalence of garden or livestock ownership was higher among cases (78.3%) than controls (56.2%) ($p < 0.01$).

Table 1. Descriptive statistics for cases and controls.

Variable	Cases $n = 337$	Controls $n = 685$	p-value
Demographics			
Age (years), mean (SD)	58.5 (8.38)	55.1 (6.56)	0.00
Female, n (%)	248 (73.6)	509 (74.4)	0.81
Ethnic identity, n (%)			0.10
Kazakh	235 (69.7)	511 (74.6)	
Uzbek	102 (30.3)	174 (25.4)	
Tertiary or higher education, n (%)	117 (34.7)	374 (54.6)	0.00
Marital status, n (%)			0.00
Married	281 (83.4)	543 (79.3)	
Cohabiting	10 (3.0)	83 (12.1)	
Divorced	7 (2.1)	36 (5.2)	
Widow(er)	39 (11.5)	23 (3.4)	
Births given (women only), n (%)			0.00
One	0 (0.0)	26 (5.1)	
Two	25 (10.1)	80 (15.7)	
Three or more	223 (89.9)	403 (79.2)	
Socioeconomics and lifestyle			
SES, n (%)			0.00
Low	11 (3.3)	111 (16.2)	
Middle	315 (93.4)	484 (70.7)	
High	11 (3.3)	90 (13.1)	
Type of job, n (%)			0.00
Sedentary	31 (9.2)	227 (33.1)	
Light/moderate physical work	255 (75.7)	411 (60.0)	
Heavy physical work	51 (15.1)	47 (6.9)	
Commuting mode, n (%)			0.02
Bus/Walk	216 (64.1)	389 (56.8)	
Car	121 (35.9)	296 (43.2)	
Participated in sports ≥6 months, n (%)	119 (35.3)	136 (19.8)	0.00
Daily five-time prayers ≥10 years, n (%)	64 (19.0)	107 (15.6)	0.17
Smoking status, n (%)	47 (13.9)	118 (17.2)	0.18
Environmental			
Area of residence			0.00
Urban	208 (61.7)	629 (91.8)	
Rural	129 (38.3)	56 (8.2)	
Low dinner table (floor sitting), n (%)	247 (73.3)	266 (38.8)	0.00
Squat toilet/ pit latrine	223 (66.2)	299 (43.6)	0.00
Owns garden / livestock, n (%)	264 (78.3)	385 (56.2)	0.00
Traditional cradle (besik), n (%)	177 (52.5)	398 (58.1)	0.09
Clinical Characteristics			
BMI (kg/m^2), mean (SD)	31.0 (6.09)	30.3 (5.28)	0.07
High blood pressure, n (%)	229 (67.9)	202 (29.49)	0.00
Hysterectomy (women only), n (%)	24 (9.7)	35 (6.9)	0.18
Bowlegs, n (%)	191 (56.7)	289 (42.2)	0.00
Flatfeet, n (%)	15 (4.5)	50 (7.3)	0.08

SES, socioeconomic status; BMI, body mass index.
Note: Continuous variables were compared using t-tests, while categorical variables were compared using chi-square tests.

Among the cases, approximately one quarter had unilateral KOA (23.1%), while the majority had bilateral involvement (76.9%). Based on clinical examination and radiographic evaluation, just over half of the cases (54.9%) had moderate to severe KOA, with the remainder classified as mild (45.1%).

The logistic regression analysis in Table 2 reveals strong and consistent associations between low dining habits, squat toilet or pit latrine usage, and KOA. No tested interaction terms were statistically significant, and all models were therefore presented without interaction effects. The final model demonstrated adequate calibration (Hosmer–Lemeshow $p = 0.16$) and appropriate specification (hatsq $p = 0.57$). No evidence of multicollinearity was observed, with all VIF values close to 1.0 (mean VIF = 1.02).

Individuals who commonly dine at low tables had significantly higher odds of KOA across all models, including after adjusting for known risk factors such as age, BMI, bowlegs, and heavy physical work. The odds ratios for low dining habits ranged from approximately 4.25 to 4.32. Similarly, the use of squat toilets or pit latrines showed robust associations, with ORs ranging from 2.26 to 2.34 across the models.

Living in a rural area, along with having livestock or a garden, also emerged as a significant factor associated with knee OA risk. Rural residence was associated with dramatically increased odds of KOA, with ORs consistently exceeding 7.5 across adjusted models. Similarly, individuals involved in livestock rearing or gardening showed elevated odds. Adjustments for factors such as tertiary education, participation in sports, and bowlegs in the fully adjusted model did not entirely account for the observed associations.

Figure 1 presents a forest plot summarizing the adjusted odds ratios and 95% confidence intervals for the key cultural and environmental exposures included in the fully adjusted model.

4. Discussion

The findings of this study suggest that cultural and lifestyle factors show strong associations with KOA in populations where traditional practices are deeply rooted. Among these, the habitual use of low dinner tables, pit toilets, and rural lifestyles was consistently associated with KOA in this study.

The practice of using low dinner tables was associated with KOA, likely because it involves prolonged and repetitive knee flexion. This tradition of floor sitting, widely observed in Kazakhstan and similar regions, involves prolonged knee flexion that may place additional stress on the joints, which could help explain its observed association with KOA. These findings are consistent with reports from East and South Asian populations, where floor sitting, kneeling, and squat toilet use have shown associations with KOA [12–15]. Our results extend this evidence to Central Asia, suggesting that these culturally embedded behaviors may be relevant across diverse settings with different traditions and routines. In Kazakh culture, the social custom of spending prolonged periods at the table, often extending to lengthy conversations over tea, may further increase the time spent in floor-seated positions, which may increase time spent in floor-seated positions and could help explain the association observed [22]. For women in Kazakhstan, these effects might be compounded by traditional social roles, which often involve remaining seated at the table for extended periods and refilling tea for others [23].

Similarly, the practice of squatting, commonly required when using pit latrines, may also place substantial mechanical stress on the knees. These cultural habits, while intrinsic to daily life, involve postures that increase knee flexion, which may help explain their observed association with joint strain. Prolonged or repetitive

Table 2. Logistic regression analysis for factors associated with KOA.

Variable	Unadjusted model	Adjusted for matching variables model	Fully adjusted model
Low dinner table (floor sitting)	4.32* (3.12, 5.97)	4.35* (3.12, 6.07)	4.25* (3.02, 5.99)
Squat toilet/ pit latrine	2.26* (1.65, 3.09)	2.34* (1.70, 3.23)	2.32* (1.66, 3.23)
Rural residence	6.84* (4.64, 10.11)	7.57* (5.06, 11.32)	7.57* (4.99, 11.48)
Owns garden / livestock	2.78* (1.97, 3.94)	2.72* (1.90, 3.89)	2.67* (1.85, 3.86)
Bowlegs	1.93* (1.42, 2.64)	1.84* (1.34, 2.53)	1.83* (1.32, 2.54)
Age		1.07* (1.05, 1.09)	1.07* (1.05, 1.10)
Female		0.85 (0.60, 1.22)	0.89 (0.62, 1.29)
BMI		1.02 (1.00, 1.05)	1.02 (0.99, 1.05)
Tertiary or higher education			0.45* (0.32, 0.62)
Participated in sports ≥6 months			2.08* (1.44, 3.01)
Heavy physical work			2.29* (1.36, 3.88)

BMI, body mass index. *$p < 0.001$.

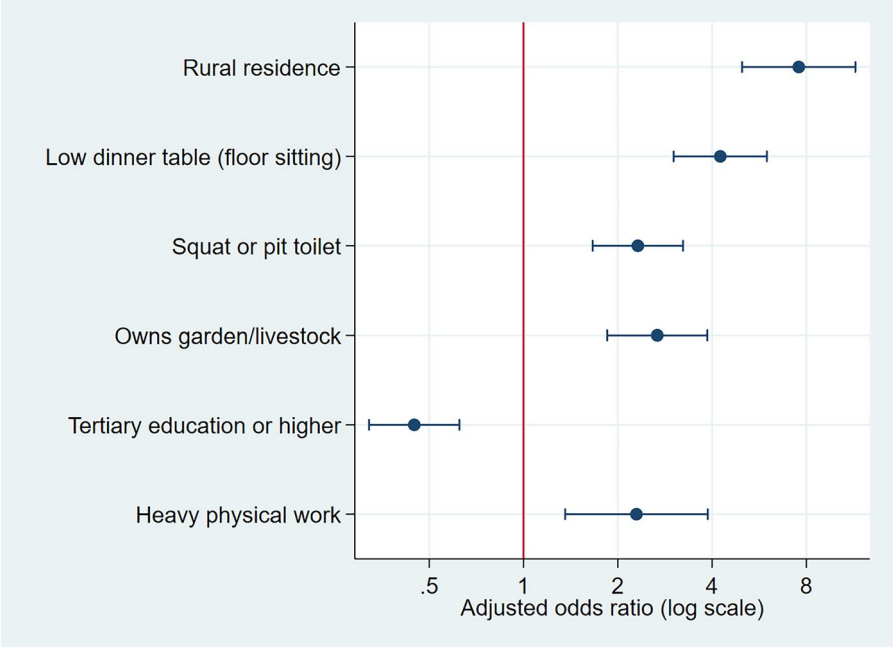

Figure 1. Adjusted odds ratios and 95% confidence intervals for key factors associated with knee osteoarthritis.

flexed postures can also contribute to myofascial pain syndrome, a condition characterized by painful trigger points in surrounding muscles. In older adults with KOA, such myofascial involvement is common and is associated with higher pain intensity and poorer function [24]. Studies of pain modulation show that long-term mechanical loading, such as repeated kneeling or deep flexion, may not only damage joint structures but also increase the sensitivity of the nerves in and around the knee. Over time, this can promote central and peripheral sensitization, where the pain system becomes more reactive and amplifies incoming signals [25]. This provides a complementary explanation for why some individuals with high cumulative joint load experience more intense symptoms.

An additional consideration is the potential for reverse causality. Individuals experiencing early or intermittent knee pain may deliberately reduce or avoid activities such as squatting or floor sitting, which could distort or weaken observed associations. Although the case–control design identifies group differences, it cannot determine whether cultural practices preceded symptom onset or were modified in response to early discomfort.

The study also highlights the potential impact of rural residence, which is often associated with physically demanding activities such as farming, gardening, and livestock care. However, these associations should be interpreted cautiously, as rural residence encompasses a wide range of lifestyle factors. Similar findings have been reported in rural cohorts from China and India, where agricultural and outdoor work were associated with higher KOA burden [18,26,27]. These parallels indicate that certain mechanical demands of rural living may be relevant across different cultural settings, even when the specific tasks vary. Additionally, these rural–urban differences may partly reflect occupational patterns in the region. In our sample, rural residents were more likely to engage in heavy physical work or formal agricultural tasks, which may increase cumulative knee loading and potentially mediate the strong association observed between rural living and KOA. Differences in dietary patterns between people living in rural areas and those in cities may also play a role. A recent systematic review found that gut microbiota profiles and tryptophan-derived metabolites influence systemic inflammation and OA-related pain, suggesting that lifestyle factors such as diet may interact with mechanical exposures to shape KOA risk [28]. While our study did not assess dietary habits, these findings provide a broader context for understanding rural–urban variation. Differences in exposure to weather conditions may also be relevant. Urban residents often work indoors, whereas rural residents spend more time outdoors and experience greater exposure to temperature changes, humidity, and other climatic conditions. Evidence from a large retrospective cohort study shows that these climatic factors influence musculoskeletal pain intensity, suggesting that environmental conditions could further contribute to rural–urban differences in KOA symptoms [29].

The practice of daily five-time prayer, involving kneeling and specific sitting postures, was also examined. While culturally significant, it did not differ meaningfully between cases and controls in this study, suggesting no independent association with KOA when other factors are considered. Interestingly, this contrasts with reports from other predominantly Muslim populations where kneeling postures were more strongly correlated with knee symptoms [15,30]. Such differences may reflect variations in prayer duration, surface conditions, lower-limb strength, or broader lifestyle patterns. It is also possible that the biomechanical load during prayer is intermittent and relatively short in duration, producing far less cumulative stress on the knee joint than habitual squatting or prolonged floor sitting. These contrasts highlight the importance of interpreting cultural practices within their specific social and behavioral contexts rather than assuming uniform effects across regions.

The inclusion of demographic and lifestyle variables in adjusted models emphasizes their potential roles as confounding factors. For example, age and BMI are established contributors to KOA, and gender differences in traditional practices may help explain some of the observed patterns. Other factors, such as heavy physical work and a history of sports participation, also showed associations consistent with increased knee strain.

Global initiatives like the WHO Global Action Plan on Physical Activity 2018–2030, which aim to promote healthier lifestyles and reduce the burden of conditions such as KOA, should consider regional lifestyle patterns when implemented locally [31]. In many regions, long-standing cultural practices place unique mechanical demands on the knees. Rather than attempting to eliminate these deeply rooted behaviors, promoting context-specific ergonomic adaptations, such as floor chairs with back and knee support or wedge cushions, may be a more feasible and culturally sensitive approach. Evidence from randomized trials shows that exercise-based interventions produce meaningful improvements in pain and function for people with KOA, supporting the role of ergonomic and movement-focused strategies within conservative management [32]. Guidance on frailty management also highlights that exercise, patient education, and community-level support are essential for maintaining function and reducing disability in older adults, reinforcing the rationale for movement-based and context-appropriate strategies in culturally diverse settings [33]. Integrating such tailored strategies can enhance the relevance and effectiveness of global health interventions.

5. Limitations

This study has several limitations that warrant consideration. First, its retrospective nature, recruitment variations, and reliance on self-reported data may introduce recall bias, misclassification or selection bias, potentially affecting the accuracy of information on cultural practices and lifestyle factors. Second, some cultural practices were measured categorically, which do not capture frequency, duration, or lifetime exposure. This limits interpretation of potential dose–response relationships for these behaviors. In addition, certain comorbidities were not included in the final adjusted models due to incomplete or inconsistent reporting, which may have limited our ability to fully adjust for broader potential confounders. The focus on South Kazakhstan region limits the generalizability of findings to other Central Asian regions with differing cultural contexts or modernization levels. Finally, the dynamic nature of lifestyles, including variations in adherence to traditional practices or shifts toward modernization, is not fully accounted for, which may affect the observed associations. These limitations highlight the need for cautious interpretation and further research to validate the findings in broader and more diverse settings.

6. Conclusion

This study provides evidence that traditional cultural practices, including frequent floor sitting, squat toilet use, and rural lifestyles, are significantly associated with an increased risk of KOA in Central Asia. The habitual knee flexion required by these practices may help explain their observed association with KOA, underscoring the need for greater public health awareness. While factors such as age, obesity, and occupational strain remain key contributors, our findings highlight the importance of considering culturally embedded behaviors when developing KOA prevention and management strategies. Future research should examine longitudinal data to clarify temporal relationships and evaluate whether ergonomic or educational adaptations could help reduce joint strain while fully respecting cultural traditions.

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Nil.

Ethical statement

The study protocol was reviewed and approved by the institutional review board of Akhmet Yassawi International Kazakh-Turkish University. Informed consent was obtained from all participants prior to their inclusion in the study.

Author contributions

All authors contributed to the conceptualization and methodological design of the study. Data investigation and data curation were carried out by Yerden Khaumet, Ikilas Moldaliyev, Azamat Seksenbayev, Ainash Oshibayeva, Saltanat Kyrykbayeva, Gulnaz Nuskabayeva, and Akylbek Ibragim. Formal analysis was performed by Almasbek Akhmetov, Yerden Khaumet, and Azamat Seksenbayev. Project administration and funding acquisition were undertaken by Yerden Khaumet. The first draft of the manuscript was written by all authors. Manuscript review and editing were completed by Yerden Khaumet, Ikilas Moldaliyev, and Azamat Seksenbayev. All authors read and approved the final manuscript.

Disclosure statement

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ORCID

Almasbek Akhmetov http://orcid.org/0009-0007-1923-3612
Yerden Khaumet http://orcid.org/0009-0002-1429-4671

Ikilas Moldaliyev http://orcid.org/0009-0007-0452-3094
Azamat Seksenbayev http://orcid.org/0009-0009-4946-677X
Ainash Oshibayeva http://orcid.org/0000-0002-5655-5465
Saltanat Kyrykbayeva http://orcid.org/0000-0001-6151-6025
Gulnaz Nuskabayeva http://orcid.org/0000-0003-2139-3221

Data availability statement

The dataset used in this study is available in the figshare repository (DOI: 10.6084/m9.figshare.29856644.v1). The dataset is titled "Turkestan cases controls.dta" and was published by Khaumet, Yerden (2025). The data can be accessed and downloaded directly from the following link: https://doi.org/10.6084/m9.figshare.29856644.v1.

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