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Research Article

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Work-related factors of knee osteoarthritis in Korean farmers: a cross-sectional study

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Abbreviations
BMI: body mass index; CI: confidence interval; CLWT: cumulative heavy lifting working time; CSWT: cumulative squatting working time; IKDC: International Knee Documentation

ABSTRACT

Background: Several studies have reported a high prevalence of osteoarthritis (OA) of the knee among agricultural workers. We investigated work-related factors that increase the risk of knee OA among Korean farmers.
Methods: Data were extracted from the Jeonnam Center for Farmer's Safety and Health survey, conducted between 2013 and 2015. The sample included 489 farmers (man 240, woman 249). We defined knee OA as radiographic knee OA (≥ Kellgren-Lawrence grade 2) with symptoms (≥ Western Ontario and McMaster Universities Osteoarthritis, Korean version score 29.5). We considered covariates such as cumulative squatting working time (CSWT), cumulative heavy lifting working time (CLWT), body mass index (BMI), and history of knee injury. Odds ratios (ORs) and their corresponding 95% confidence intervals (CIs) were calculated for knee OA and adjusted for relevant covariates.
Results: The results of multivariate logistic regression analysis indicated that knee OA was correlated by factors such as sex, age, BMI, history of knee injury, CSWT, and CLWT. Particularly, CSWT > 20,000 hours (OR: 2.83; 95% CI: 1.35–5.92; reference < 10,000 hours) and CLWT > 5,000 hours (OR: 2.62; 95% CI: 1.14–6.06; reference < 2,000 hours) were associated with an increased risk of knee OA after adjustment for covariates.
Conclusions: Squatting posture and heavy lifting associated with farm work might increase the risk of knee OA among Korean farmers.

Keywords: Knee; Osteoarthritis; Farmers; Korea; Agriculture; Occupations

BACKGROUND

Osteoarthritis (OA) is emerging as a public health challenge worldwide [1]. Population aging is increasing in the prevalence of OA. Particularly, knee OA, which accounts for the largest proportion of OA cases, contributes to the deterioration of quality of life and the increase of disability-adjusted life years [2,3].

In 2017, the World Health Organization-Global Burden of Disease study revealed that the percentage change in prevalence between 2007–2017 was 30.8% (vs. all causes 17.0%, neoplasms 40.6%, COPD 23.8%) [4]. In Korea, the prevalence of knee OA, defined by

Committee; KFKC: Korean Farmer's Knee Cohort; KL: Kellgren-Lawrence; K-WOMAC: Korean version of Western Ontario and McMaster Universities Arthritis Index; OA: osteoarthritis; OR: odds ratio; SOA: radiographic osteoarthritis with symptoms.

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Competing interests

The authors declare that they have no competing interests.

Authors contributions

Conceptualization: Song H; Data curation: Kim DH, Lee G, Song H; Investigation: Lee C, Song H; Methodology: Lee C, Kim DH, Kim KY, Song H; Writing - original draft: Song H; Writing - review & editing: Lee C, Kim DH, Kim KY, Ryu SY.

knee pain and radiologic findings, was estimated at 4.4% and 19.2% in men and women, respectively, according to the fifth Korean National Health and Nutrition Examination Survey [5]. As the prevalence of knee OA is rising, knee arthroplasty also markedly increased by 407% in 2010 compared to 2001. The 91% of those who received knee arthroplasty were women [6]. The presence of OA patients in Korean households can create catastrophic health expenditure [7].

Knee OA is a degenerative disease [8]. There are several risk factors for knee OA, such as lower limb malalignment, obesity, occupational activity, and knee injury [9]. Kneeling, squatting, lifting or carrying, climbing stairs, and heavy manual work have previously been reported as occupational risk factors [10-12]. Most studies have classified occupational risk factors for OA according to profession. Only few studies have attempted to identify the dose–response relationship between occupational risk factors and knee OA. In research on large-scale population, subjects' age distribution skewed toward higher age because knee OA occurs mainly in the elderly. Considering the known risk factor of knee OA, we could predict that the elderly who perform hard manual labor are vulnerable to knee OA. The average age of Korean farmers is approximately 60 years old. Despite the mechanization of agriculture, competitive price crops—field crops, fruit farming, and livestock—still require a higher amount of manual labor. A previous study has shown that the prevalence of knee OA among farmers is high [13]. This study therefore aimed to investigate the dose–response relationship between occupational risk factors and knee OA among Korean working farmers who perform heavy manual labor.

METHODS

Participants

This cross-sectional study was conducted using data from Korean Farmer's Knee Cohort (KFKC). KFKC was initiated by the Jeonnam Center for Farmer's Safety and Health to investigate work-related factors and their impact on knee OA risk among Korean farmers. The cohort participants were recruited from 16 agricultural production units in the Jeonnam province in southwest Korea. Farmers were enrolled in the 2013–2015 years. In the present study, of the 550 registered cohort members, 489 farmers between the ages of 40 and 69 were selected.

Data collection

We extracted data on the knee OA status and associated risk factors from the medical checkup and questionnaire results. The questionnaire-based survey was conducted face-to-face by trained researchers. Details on sex, age, previous knee injury, knee symptoms, and detailed information about agricultural physical activity were extracted from the questionnaire-based data. To measure how much time the farmers spent working in a specific position (squatting or lifting), we took the unit task exposure as the median value of each sub-periods exposure and then calculated cumulative squatting working time (CSWT) and cumulative heavy lifting working time (CLWT) by the following formula (**Table 1**):

$$\text{Cumulative working time (hours)} = \text{Working years for lifetime} \times \text{Working months per year} \times 4 \times \text{Working days per week} \times \text{Working hours per day}$$

Researchers measured the weight and height of the cohort participants during a medical screening appointment. We calculated body mass index (BMI; kg/m^2) based on height and

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Table 1. The matrix for calculation of cumulative squatting or heavy lifting working time

Working years for lifttime (A)		Working months per 1 year (B)		Working days per 1 week (C)		Working hours per day (D)	
Criterion (years)	Rating	Criterion (months)	Rating	Criterion (days)	Rating	Criterion (hours)	Rating
< 5	2.5	< 1	0.5	< 1	0.5	< 1	0.5
5–9	7.0	1–2	2.0	1–2	1.5	1–2	1.5
10–19	14.5	3–6	4.5	3–4	3.5	3–4	3.5
20–29	24.5	7–9	8.0	5–6	5.5	5–6	5.5
30–39	34.5	9–12	10.5	7	7.0	7–8	7.5
≥ 40	40.0					> 8	8.0

Cumulative working time = A × B × 4 × C × D.

weight data. Knee symptoms were investigated by the Korean version of Western Ontario and McMaster Universities Arthritis Index (K-WOMAC), which includes items such as pain, stiffness, and disability [14]. Knee OA in this study was confirmed with significant radiographic findings and symptoms reported in the structured questionnaire. The radiographic criteria were the knee Kellgren-Lawrence (KL) grade of 2 or higher [15]. The symptomatic criterion was the K-WOMAC score of 30 or higher [16].

Radiographic assessment

The standardized weight-bearing anteroposterior and Rosenberg radiographs of the femorotibial joint were acquired. Interobserver reliability of KL grade was confirmed by 2 experienced orthopedic surgeons who used the Osteoarthritis Research Society International atlas [17]. The cut-off point for joint space narrowing was 4 mm based on the International Knee Documentation Committee (IKDC) radiographic scales [15,18]. Kappa for interobserver reliability of KL grade was 0.581 in the right knee and 0.598 in the left knee. Between the 2 grades, the more severe grade was used as the final KL grade.

Statistical analysis

We performed the χ^2 test and logistic regression analysis to examine the association between knee OA and major risk factors. In the analysis, age was dichotomized as ≥ 60 and < 60, while BMI was dichotomized ≥ 25 or more and < 25. The presence of a previous knee injury was defined by answering 'yes' to a question: 'Have you ever had a knee injury that required a cast?' or 'Have you ever experienced such pain in your knee that you were not able to perform farming duties for more than a day?". CSWT was divided into < 10,000, 10,000–19,999, and ≥ 20,000 hours. CLWT was divided into 2,000, 2,000–4,999, and ≥ 5,000 hours. The CLWT 2,000 hours corresponds to the average annual working hours of Koreans. Multivariate logistic regression analysis was performed to obtain the odds ratios (ORs) and corresponding 95% confidence intervals (CIs) adjusted for major covariates. All statistical analyses were performed using IBM SPSS version 21.0 (IBM Co., Armonk, NY, USA). A p-value < 0.05 was considered statistically significant.

Ethics statement

The present study protocol was reviewed and approved by the Institutional Review Board of Chosun University Hospital (approval No. 2013-12-006). All participants provided written informed consent for participation in the survey and use of their data for research purposes.

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Table 2. The prevalence of SOA by sex and age among participants

Variables	Men (n = 240)			Women (n = 249)		
	40–49 years (n = 45)	50–59 years (n = 109)	60–69 years (n = 86)	40–49 years (n = 49)	50–59 years (n = 119)	60–69 years (n = 81)
(A) WOMAC ≥ 30	6 (13.3)	17 (15.6)	19 (22.1)	5 (10.2)	39 (32.8)	42 (51.9)
(B) KL grade ≥ 2	3 (6.7)	21 (19.3)	23 (26.7)	9 (18.4)	41 (34.5)	58 (71.6)
(A and B) SOA	1 (2.2)	5 (4.6)	8 (9.3)	2 (4.1)	18 (15.1)	30 (37.0)

Values are presented as number (%).
SOA: radiographic osteoarthritis with symptoms; WOMAC: Western Ontario and McMaster Universities Arthritis Index; KL: Kellgren-Lawrence.

RESULTS

The prevalence of knee OA

Table 2 shows the prevalence of significant knee symptoms by WOMAC, radiographic knee OA by KL grade, and radiographic knee OA with significant symptoms (radiographic OA with symptoms [SOA]) as the final outcome. The prevalence of radiographic knee OA was higher among older woman farmers. In total, 48 of 240 male farmers had radiographic knee OA; 14 cases of them were SOA. Moreover, 108 of 249 woman farmers had radiographic knee OA; 50 cases of them were SOA.

The relationships between the major covariates and the risk of knee OA

Table 3 shows the relationships between the major covariates and the risk of SOA. Sex, age, previous knee injury, CLWT, and CSWT were significantly associated with SOA. In contrast, household income and agricultural work experience were not significantly associated with SOA.

The results of multiple logistic regression analysis

Table 4 shows the results of multiple logistic regression analysis, examining the association between major risk factors and SOA. Sex, age, and BMI were significantly associated with

Table 3. Association between SOA and major risk factors

Variables	Total	Non-SOA	SOA	p^a
Sex				< 0.001
Men	240	226 (94.2)	14 (5.8)	
Women	249	199 (79.9)	49 (20.1)	
Age (years)				< 0.001
< 60	322	296 (92.9)	26 (8.1)	
≥ 60	167	129 (77.2)	38 (22.8)	
BMI (kg/m^2)				0.032
< 25	267	240 (89.4)	27 (10.6)	
≥ 25	222	185 (83.7)	37 (16.3)	
Previous knee injury				0.039
No	344	306 (89.0)	38 (11.0)	
Yes	145	119 (82.1)	26 (17.9)	
CLWT (hours)				0.001
< 2,000	156	147 (94.2)	9 (5.8)	
2,000–4,999	59	54 (91.5)	5 (8.5)	
≥ 5,000	274	224 (81.8)	50 (18.2)	
CSWT (hours)				< 0.001
< 10,000	239	226 (94.6)	13 (5.4)	
10,000–19,999	64	56 (87.5)	8 (12.5)	
≥ 20,000	186	143 (76.9)	43 (23.1)	

Values are presented as number (%).
SOA: radiographic osteoarthritis with symptoms; OR: odds ratio; CI: confidence interval; BMI: body mass index; CLWT: cumulative heavy lifting working time; CSWT: cumulative squatting working time.
[a]The p-value by χ^2 test.

Table 4. The OR of SOA according to major risk factors

Variables	Unadjusted		Adjusted[a]	
	OR	95% CI	OR	95% CI
Sex				
Men	1.00		1.00	
Women	4.06	2.18–7.56	4.59	2.33–9.06
Age (years)				
< 60	1.00		1.00	
≥ 60	3.35	1.95–5.76	4.06	2.21–7.43
BMI (kg/m^2)				
< 25	1.00		1.00	
≥ 25	1.78	1.04–3.06	2.25	1.23–4.13
Previous knee injury				
No	1.00		1.00	
Yes	1.78	1.04–3.03	2.13	1.15–3.97
CLWT (hours)				
< 2,000	1.00		1.00	
2,000–4,999	1.51	0.49–4.71	1.32	0.38–4.55
≥ 5,000	3.65	1.74–7.64	2.62	1.14–6.06
CSWT (hours)				
< 10,000	1.00		1.00	
10,000–19,999	2.53	1.00–6.40	1.65	0.59–4.61
≥ 20,000	5.19	2.70–9.99	2.83	1.35–5.92

SOA: radiographic osteoarthritis with symptoms; OR: odds ratio; CI: confidence interval; BMI: body mass index; CLWT: cumulative heavy lifting working time; CSWT: cumulative squatting working time.
[a]Adjusted by all variables.

SOA. History of knee injury was significantly associated with SOA. CLWT and CSWT were associated with SOA. After adjustment, the OR of CLWT over 5,000 hours was 2.62 (95% CI: 1.14–6.06) when the reference group was less than 2,000 hours. The OR of CSWT over 20,000 hours was 2.83 (95% CI: 1.35–5.92) when the reference group was less than 10,000 hours.

DISCUSSION

In the present study, long-term squatting and heavy lifting were associated with knee OA with symptoms among Korean working farmers. These results were adjusted for age, sex, obesity, and previous knee injury, known as confounding variables. Past studies have demonstrated moderate evidence for the relationship between kneeling/squatting or heavy lifting and knee OA. The combination of kneeling/squatting and heavy lifting showed a stronger relationship with knee OA [11,12]. Evidence in literature suggests that degenerative changes in the joint include the accumulation of biomechanical load. For the cultivation of low-floor crops, Korean farmers mainly use deep squat with feet flat on the ground, known as the Asian squat. As the knee flexion angle increases, the force on the knee joint also increases [19]. The thigh-calf contact during deep squat counteracts the forces of the knee joint [20]. Nevertheless, squatting by moving forward or sideways causes a higher rotational torque in the knee joint [21]. Additionally, long working hours cause fatigue in the thigh muscles, thereby increasing the varus moment [22].

Many studies showed that heavy lifting was related to knee OA. In previous studies, heavy lifting exposure was classified according to profession, frequency of heavy lifting, or maximum weight of heavy objects [12]. Therefore, only few studies attempted quantitative analysis for heavy lifting exposure. In the present study, quantification of exposure was performed by calculating the amount of working time related to heavy lifting. Heavy lifting of

more than 5,000 hours in agriculture shows a significant relationship with knee OA. These results indicated that the burden of physical agricultural work might help explain the high prevalence of knee OA among farmers.

In our study, the adjusted OR for knee OA was 4.59 higher in women than in men. The previous knee OA studies have consistently shown that women are more vulnerable than men to knee OA, which also progresses more quickly in women than in men [23]. A previous study has found a higher prevalence of knee OA among Chinese women than white American women [24]. One study of knee OA in Asia, including participants from China, Japan, and Korea, showed that the prevalence of knee OA among Korean women was higher than among women from other countries [25]. Women's vulnerability to knee OA might be explained by menopausal changes to estrogen [26], femoral-tibia length [27], femoral bowing [28], socioeconomic differences [29], and squatting posture in daily life [30]. However, further research is needed to confirm the associations.

There was a correlation between obesity and knee OA in the present study, which is consistent with findings from previous studies. Previous studies on the impact of obesity on knee OA have shown that, compared to normal weight, BMI of 30 or more is a risk factor for OA. Moreover, large-scale studies have shown an increased risk of knee OA even among participants who were overweight (BMI 25–30) [31,32]. In many epidemiological studies, knee OA has been defined as a case of simultaneous radiologic knee OA and symptomatic knee OA [33]. Radiological knee OA is conventionally assessed with the KL grade [15]. However, there is a large variation in the reported reliability and validity of KL grade in each study [34]. These discrepancies might be due to the ambiguity in the description of each KL grade [35] and between-observer differences in judgments on joint space narrowing [36]. To remedy this problem, researchers use standard films that are read by experienced physicians [17]. We used the 4-mm narrowing as a threshold, suggested by the IKDC, as a significant joint space narrowing [15].

Imaging methods can also cause measurement errors. The sensitivity of radiographic knee OA depends on the weight load and knee flexion angle. For example, the Rosenberg view, taken at a 45-degree knee flexion state, is more sensitive than a standing view [37]. This might better reflect the state of the posterior of the knee joint. If the plateau of the tibia is not clear in the image, it can be checked in the lateral view. Since our study considered all 4 views, our knee OA assessment might have been more sensitive than the assessment in studies that only considered 1 or 2 views.

This study has the following limitations. First, the participants were restricted to farmers living in the Jeonnam province in Korea. Therefore, the results of this study cannot be generalized to all farmers in Korea. However, the participants were members of the regional producer organizations or cultivation groups. Jeonnam province is the largest agricultural region in Korea. Second, the definition of radiological knee OA is generally applied by KL grade 2 or higher. However, there are no agreed criteria on the symptoms of knee OA. We used K-WOMAC to assess knee symptoms. However, other studies used a doctor's examination or a single questionnaire to assess knee symptoms. Differences in the methodology of symptom assessment should be considered when comparing the present and previous study findings. Third, CLWT and CSWT were insufficient to verify reliability and validity. The CLWT and CSWT had bimodal and right-skewed distribution. We categorized the cumulative working time into 3 levels. A small number of the intermediate level of CLWT and CSWT could make increase the OR's random error. Therefore, attention should be

paid to interpreting the working time showing significant relevance to SOA in this study. Fourth, this study has limitations inherent to a cross-sectional study. Study participants were recruited to follow up the on development or progression of knee OA. Therefore, farmers with terminal stage knee or knee arthroplasty were excluded from the cohort registration. As a result, the impact of the burden of farm work on the risk of developing knee OA is likely to be underestimated. Fifth, considering sex differences in knee OA, it is reasonable to analyze men and women separately. However, this analysis was not attempted owing to the lack of cases. Despite these limitations, this study was the first study to identify work-related risk factors for knee OA among Korean farmers.

In conclusion, after adjusting confounding factors, cumulative squatting and heavy lifting working time had a dose-response relationship with knee OA among Korean farmers. The result suggests that agricultural work, such as long period squatting posture, heavy lifting is convincing evidence of the high prevalence of knee OA in Korean farmers.

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REFERENCES

1. Cross M, Smith E, Hoy D, Nolte S, Ackerman I, Fransen M, et al. The global burden of hip and knee osteoarthritis: estimates from the global burden of disease 2010 study. Ann Rheum Dis 2014;73(7):1323-30.
PUBMED | CROSSREF
2. Kim IJ, Kim HA, Seo YI, Jung YO, Song YW, Jeong JY, et al. Prevalence of knee pain and its influence on quality of life and physical function in the Korean elderly population: a community based cross-sectional study. J Korean Med Sci 2011;26(9):1140-6.
PUBMED | CROSSREF
3. Hunter DJ, Schofield D, Callander E. The individual and socioeconomic impact of osteoarthritis. Nat Rev Rheumatol 2014;10(7):437-41.
PUBMED | CROSSREF
4. GBD 2017 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet 2018;392(10159):1789-858.
PUBMED | CROSSREF
5. Lee S, Kim SJ. Prevalence of knee osteoarthritis, risk factors, and quality of life: The Fifth Korean National Health and Nutrition Examination Survey. Int J Rheum Dis 2017;20(7):809-17.
PUBMED | CROSSREF
6. Koh IJ, Kim TK, Chang CB, Cho HJ, In Y. Trends in use of total knee arthroplasty in Korea from 2001 to 2010. Clin Orthop Relat Res 2013;471(5):1441-50.
PUBMED | CROSSREF
7. Kim H, Cho SK, Kim D, Kim D, Jung SY, Jang EJ, et al. Impact of osteoarthritis on household catastrophic health expenditures in Korea. J Korean Med Sci 2018;33(21):e161.
PUBMED | CROSSREF
8. Kim I, Kim HA, Seo YI, Song YW, Jeong JY, Kim DH. The prevalence of knee osteoarthritis in elderly community residents in Korea. J Korean Med Sci 2010;25(2):293-8.
PUBMED | CROSSREF
9. Silverwood V, Blagojevic-Bucknall M, Jinks C, Jordan JL, Protheroe J, Jordan KP. Current evidence on risk factors for knee osteoarthritis in older adults: a systematic review and meta-analysis. Osteoarthritis Cartilage 2015;23(4):507-15.
PUBMED | CROSSREF

10. McWilliams DF, Leeb BF, Muthuri SG, Doherty M, Zhang W. Occupational risk factors for osteoarthritis of the knee: a meta-analysis. Osteoarthritis Cartilage 2011;19(7):829-39.
PUBMED | CROSSREF
11. Palmer KT. Occupational activities and osteoarthritis of the knee. Br Med Bull 2012;102(1):147-70.
PUBMED | CROSSREF
12. Jensen LK. Knee osteoarthritis: influence of work involving heavy lifting, kneeling, climbing stairs or ladders, or kneeling/squatting combined with heavy lifting. Occup Environ Med 2008;65(2):72-89.
PUBMED | CROSSREF
13. Seok H, Choi SJ, Yoon JH, Song GG, Won JU, Kim JH, et al. The association between osteoarthritis and occupational clusters in the Korean population: a nationwide study. PLoS One 2017;12(1):e0170229.
PUBMED | CROSSREF
14. Bae SC, Lee HS, Yun HR, Kim TH, Yoo DH, Kim SY. Cross-cultural adaptation and validation of Korean Western Ontario and McMaster Universities (WOMAC) and Lequesne osteoarthritis indices for clinical research. Osteoarthritis Cartilage 2001;9(8):746-50.
PUBMED | CROSSREF
15. Kohn MD, Sassoon AA, Fernando ND. Classifications in brief: Kellgren-Lawrence classification of osteoarthritis. Clin Orthop Relat Res 2016;474(8):1886-93.
PUBMED | CROSSREF
16. Giesinger JM, Hamilton DF, Jost B, Behrend H, Giesinger K. WOMAC, EQ-5D and knee society score thresholds for treatment success after total knee arthroplasty. J Arthroplasty 2015;30(12):2154-8.
PUBMED | CROSSREF
17. Altman RD, Gold GE. Atlas of individual radiographic features in osteoarthritis, revised. Osteoarthritis Cartilage 2007;15 Suppl A:A1-56.
PUBMED | CROSSREF
18. Wright RW; MARS Group. Osteoarthritis classification scales: Interobserver reliability and arthroscopic correlation. J Bone Joint Surg Am 2014;96(14):1145-51.
PUBMED | CROSSREF
19. Smith SM, Cockburn RA, Hemmerich A, Li RM, Wyss UP. Tibiofemoral joint contact forces and knee kinematics during squatting. Gait Posture 2008;27(3):376-86.
PUBMED | CROSSREF
20. Zelle J, Barink M, Loeffen R, De Waal Malefijt M, Verdonschot N. Thigh-calf contact force measurements in deep knee flexion. Clin Biomech (Bristol, Avon) 2007;22(7):821-6.
PUBMED | CROSSREF
21. Lee CG, Hong WK. Analysis on biomechanical differences depending on changes in postures during farm work. J Ergon Soc Korea 2016;35(5):307-17.
CROSSREF
22. Hong WK, Lee CG, Ko DS. Effect of thigh muscle fatigue on the biomechanical factors of the lower limbs when walking in a squatted position. J Phys Ther Sci 2016;28(3):1007-11.
PUBMED | CROSSREF
23. Srikanth VK, Fryer JL, Zhai G, Winzenberg TM, Hosmer D, Jones G. A meta-analysis of sex differences prevalence, incidence and severity of osteoarthritis. Osteoarthritis Cartilage 2005;13(9):769-81.
PUBMED | CROSSREF
24. Zhang Y, Xu L, Nevitt MC, Aliabadi P, Yu W, Qin M, et al. Comparison of the prevalence of knee osteoarthritis between the elderly Chinese population in Beijing and whites in the United States: The Beijing Osteoarthritis Study. Arthritis Rheum 2001;44(9):2065-71.
PUBMED | CROSSREF
25. Fransen M, Bridgett L, March L, Hoy D, Penserga E, Brooks P. The epidemiology of osteoarthritis in Asia. Int J Rheum Dis 2011;14(2):113-21.
PUBMED | CROSSREF
26. Richmond RS, Carlson CS, Register TC, Shanker G, Loeser RF. Functional estrogen receptors in adult articular cartilage: estrogen replacement therapy increases chondrocyte synthesis of proteoglycans and insulin-like growth factor binding protein 2. Arthritis Rheum 2000;43(9):2081-90.
PUBMED | CROSSREF
27. Conley S, Rosenberg A, Crowninshield R. The female knee: anatomic variations. J Am Acad Orthop Surg 2007;15 Suppl 1:S31-6.
PUBMED | CROSSREF
28. Do S, Lee CG, Kim DH, Lee G, Kim KY, Ryu SY, et al. Factors related to femoral bowing among Korean female farmers: a cross-sectional study. Ann Occup Environ Med 2020;32(1):e23.
PUBMED | CROSSREF

29. Luong ML, Cleveland RJ, Nyrop KA, Callahan LF. Social determinants and osteoarthritis outcomes. Aging Health 2012;8(4):413-37.
PUBMED | CROSSREF

30. Zhang Y, Hunter DJ, Nevitt MC, Xu L, Niu J, Lui LY, et al. Association of squatting with increased prevalence of radiographic tibiofemoral knee osteoarthritis: the Beijing Osteoarthritis Study. Arthritis Rheum 2004;50(4):1187-92.
PUBMED | CROSSREF

31. Zhou ZY, Liu YK, Chen HL, Liu F. Body mass index and knee osteoarthritis risk: a dose-response meta-analysis. Obesity (Silver Spring) 2014;22(10):2180-5.
PUBMED | CROSSREF

32. Guimaraes JB, Nevitt MC, McCulloch CE, Schwaiger BJ, Gersing AS, Facchetti L, et al. Association of weight change with progression of meniscal intrasubstance degeneration over 48 months: Data from the Osteoarthritis Initiative. Eur Radiol 2018;28(3):953-62.
PUBMED | CROSSREF

33. Zhang Y, Jordan JM. Epidemiology of osteoarthritis. Clin Geriatr Med 2010;26(3):355-69.
PUBMED | CROSSREF

34. Schiphof D, de Klerk BM, Koes BW, Bierma-Zeinstra S. Good reliability, questionable validity of 25 different classification criteria of knee osteoarthritis: a systematic appraisal. J Clin Epidemiol 2008;61(12):1205-1215.e2.
PUBMED | CROSSREF

35. Schiphof D, de Klerk BM, Kerkhof HJ, Hofman A, Koes BW, Boers M, et al. Impact of different descriptions of the Kellgren and Lawrence classification criteria on the diagnosis of knee osteoarthritis. Ann Rheum Dis 2011;70(8):1422-7.
PUBMED | CROSSREF

36. Guermazi A, Hunter DJ, Li L, Benichou O, Eckstein F, Kwoh CK, et al. Different thresholds for detecting osteophytes and joint space narrowing exist between the site investigators and the centralized reader in a multicenter knee osteoarthritis study--data from the Osteoarthritis Initiative. Skeletal Radiol 2012;41(2):179-86.
PUBMED | CROSSREF

37. Babatunde OM, Danoff JR, Patrick DA Jr, Lee JH, Kazam JK, Macaulay W. The combination of the tunnel view and weight-bearing anteroposterior radiographs improves the detection of knee arthritis. Arthritis (Egypt) 2016;2016:9786924.
PUBMED | CROSSREF