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Original Article

# Work-Related Risk Factors of Knee Meniscal Tears in Korean Farmers: A Cross-Sectional Study

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ABSTRACT

*Background:* Meniscal tears are among the major risk factors for knee osteoarthritis progression. This study aimed to investigate the relationship between meniscal tears and work-related factors in the farming occupation.
*Methods:* The participants included 486 farmers (238 men and 248 women), aged 40–69 years, who were among the 550 farmers registered in the Korea Farmer's Knee Cohort (KFKC). Data such as those on gender, age, body mass index (BMI), mechanical axis, cumulative heavy-lifting working time (CLWT), cumulative squatting working time (CSWT), and previous knee injury history were collected from the questionnaire, along with whole leg radiographic findings. Two radiologists assessed the magnetic resonance images of both knees to confirm the presence of meniscal tears. The factors related to meniscal tears were analyzed by multiple logistic regression.
*Results:* A total of 54.5% of the farmers (48.7% of men and 60.1% of women) had meniscal tears. These tears were associated with gender, age, and BMI. We also identified an association between meniscal tears and CSWT, an especially important factor in farming [10,000–19,999 working hours, odds ratio = 2.16, 95% confidence interval (CI): 1.14-4.07, ≥20,000 working hours, odds ratio = 2.35, 1.45-3.80]. However, mechanical axis, knee injury history, and CLWT were not significantly related to meniscal tears.
*Conclusion:* This study's findings show that squatting for long periods, as an occupational factor, is related to meniscal tears.


## 1. Introduction

A meniscus is a semilunar-shaped fibrocartilaginous articular disc that is located between the femur and tibia. It absorbs shock, transmits load, and provides stability to the knee joint [1]. The meniscus is functionally important, and negative effects of meniscal tears on knee osteoarthritis have been noted.

Meniscal tears are of two types: traumatic and degenerative. Traumatic tears occur more commonly in younger age groups and are often vertical in nature, including radial, flap, and longitudinal tears. Traumatic meniscal tears are identified by the onset of sudden knee pain and require surgical intervention. In contrast, the prevalence of degenerative tears increases with age; most of these types of tears are horizontal and asymptomatic, and conservative treatment is recommended in most cases [2,3]. The frequency of surgical treatment for meniscal tears is bimodally distributed. Recently, the importance of meniscal preservation has been emphasized, with the numbers of meniscectomy cases decreasing and those of repair cases increasing [4–6].

Degenerative meniscal tears were commonly observed among middle-aged and elderly people [7]. Incidental meniscal tears account for about 60% of all such tears [8]. In one study, the prevalence of meniscal tears was 63% among patients with an asymptomatic contralateral knee, who were referred for meniscal

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tear identification [9]. Meniscal tears have been reported as well-known risk factors for knee osteoarthritis in the general population [10]. Meniscal extrusion was associated with extensive cartilage loss in groups without a past history of knee osteoarthritis [11]. The production and secretion of enzymes and other procatabolic mediators by damaged menisci–induced pathological changes in the knee joint among patients with osteoarthritis [12].

Degenerative meniscal tears have been a point of focus in knee osteoarthritis–related research. A previous meta-analysis showed that meniscal tears are associated with work-related factors such as squatting, walking, stair-climbing, lifting, and carrying [13]. Some research has shown that the prevalence of degenerative meniscal tears was high in specific occupations. For example, a study conducted in Denmark found that floor layers showed a higher prevalence of medial meniscal tears than graphic designers [14]. A study conducted on air baggage handlers showed an increased incidence of meniscal damage [15].

We are concerned by the high prevalence of knee osteoarthritis observed among Korean farmers [16]. Korean farmers are mostly small-scale family farmers, and manual work is often required during sowing, pesticide spraying, and harvesting [17]. Hence, Korean farmers are expected to have a high prevalence of meniscal tears considering their large physical burden [18]. However, the prevalence of meniscal tears among farmers has not been investigated in any international studies. This study aimed to investigate the characteristics of participants experiencing meniscal tear, as well as personal and occupational factors related to meniscal tears, with a goal of better understanding factors leading to knee osteoarthritis aggravation.

## 2. Materials and methods

### *2.1. Participants*

This study included 486 farmers, aged 40–69 years, who were enrolled from among the 550 farmers registered in the Korea Farmer's Knee Cohort (KFKC) in 2013-2015. The KFKC was established for the identification of work-related factors associated with knee osteoarthritis among farmers at the Jeonnam Center for Farmers' Safety and Health, with funding from the Ministry of Agriculture, Food and Rural Affairs. The KFKC comprised 16 local agricultural production units in Jeonnam province, located in the southwest of Korea. This is a cross-sectional study of farmers registered in the KFKC.

### *2.2. Data collection*

We obtained images of both knees for the study participants; imaging was conducted using 1.5 Tesla magnetic resonance imaging (MRI) (Avanto, Siemens, USA). Two radiologists checked for the presence of meniscal tears on the medial and lateral sides of each knee and classified the patterns of tearing as per the MRI Osteoarthritis Knee Score classification system for meniscal tears [19]. The patterns of tearing were categorized into horizontal tears, radial tears, complex tears, root tears, vertical tears, and complete macerations. Meniscal tears were defined as those with a high signal intensity that extended to an articular surface on at least 2 slices. If a tear was present in any part of the knee, it was also defined as a meniscal tear. Horizontal tears were defined as those with a high signal intensity that extended to the articular surface in parallel with the tibial plateau. Radial tears were described as having high signal intensity in perpendicular to both the tibial plateau and the long axis of the meniscus. Complex tears were defined by the presence of a combination of two or more meniscal tear types. Root tears were described as radial tears that were located within 10 mm from the insertion site of the medial or lateral meniscus. Vertical tears were defined as those with a high signal intensity perpendicular to the tibial plateau and parallel to the long axis of the meniscus. Complete macerations were characterized by completely worn-out menisci [7]. The interobserver reliability, based on the intraclass correlation coefficient, was 0.882 [95% confidence interval (CI): 0.861–0.901] for right medial meniscal tears, 0.897 (95% CI: 0.879–0.913) for right lateral meniscal tears, 0.858 (95% CI: 0.832–0.880) for left medial meniscal tears, and 0.895 (95% CI: 0.876–0.912) for left lateral meniscal tears.

The mechanical axis angle was determined by the difference between the femoral mechanical axis and the tibial mechanical axis. The femoral mechanical axis extends from the center of the femoral head to the center of both tibial spines, and the tibial mechanical axis extends from the center of the ankle to the center of both tibial spines. The center of the ankle was defined as the midpoint of both malleoli. The average mechanical axis angle among Korean people is not neutral, measuring about $1^\circ$ to $2^\circ$ [20]. Therefore, the presence of an angle of $-1^\circ$ and $5^\circ$ degrees, corresponding to a standard deviation of 1 for the participants' mechanical axis angle, was defined as the cut-off point of varus deformity.

The presence of previous knee injuries was confirmed if the answer to the question, "Have you ever put on a cast with a knee injury?" or "Have you ever hurt your knee and not been able to carry out farming tasks for more than a day?" was "yes."

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 subperiod exposure and then calculated cumulative squatting working time (CSWT) and cumulative heavy-lifting working time (CLWT) by the following formula: cumulative working time (hours) = lifetime working years $\times$ working months per year $\times$ 4 $\times$ working days per week $\times$ working hours per day. CSWT was categorized into "lower than 10,000 hours", "10,000–19,999 hours", and "20,000 hours or greater", while CLWT was categorized as "lower than 2,000 hours", "2,000–4,999 hours", and "5,000 hours or higher". The frequency distribution of CSWT and CLWT was right-skewed. Multivariate logistic regression analysis was performed to obtain the odds ratios (ORs) for meniscal tears, after adjustment for major potential confounders.

### *2.3. Statistical analysis*

We performed Fisher's exact test and the Chi-square test to evaluate the association between meniscus tears, participant characteristics, and occupational factors, including gender, age, body mass index, previous knee injury history, mechanical axis angle, CSWT, and CLWT. Multiple logistic regression analysis was used to determine the associations among potential risk factors. A $P$-value $< 0.05$ was considered statistically significant. All statistical analyses were performed using IBM SPSS version 21.0 (IBM Co., Armonk, NY, USA).

### *2.4. Ethics statement*

The present study protocol was reviewed and approved by the Institutional Review Board of Chosun University Hospital (Approval No. 2013-12-006). Written informed consent was provided by all participants at enrollment, for both survey participation and the use of their data for research purposes.

**Table 1**
Characteristics of the study participants (n = 486)

| Variables | | Values |
|---|---|---|
| Age, mean ± SD (years) | | 56.12 ± 7.165 |
| Gender, n (%) | Men<br>Women | 238 (49.0)<br>248 (51.0) |
| Mechanical axis, n (%) | Neutral (<-1 degrees)<br>Valgus (-1,5 degrees)<br>Varus (>5 degrees) | 359 (73.9)<br>38 (7.8)<br>89 (18.3) |
| Previous knee injury history, n (%) | No<br>Yes | 341 (70.2)<br>145 (29.8) |
| Body mass index, mean ± SD (kg/m²) | | 24.65 ± 3.06 |
| CLWT, mean ± SD (hours) | | 16574.5 ± 20669.2 |
| CSWT, mean ± SD (hours) | | 20473.2 ± 23084.9 |

SD, standard deviation; CSWT, cumulative squatting working time; CLWT, cumulative heavy-lifting working time.

## 3. Results

### 3.1. The demographic characteristics of the study participants

Table 1 shows the demographic characteristics of the study participants. Of the 486 participants, 238 were men (49.0%) and 248 were women (51.0%). The mean age of the farmers was 56.1 (±7.2) years. Of the participants, 89 (18.3%) had a varus deformity and 38 (7.8%) a valgus deformity, as defined by the mechanical axis of the lower limbs. In the questionnaire, 145 (29.8%) of the participants reported having a knee injury experience. The participants' average body mass index (BMI) was 24.65 (±3.06) kg/m$^2$. The mean CLWT and CSWT values were 16.6 (±20.7) thousand hours and 20.5 (±23.1) thousand hours, respectively.

### 3.2. The association between age, gender, and meniscal tears

Table 2 shows the prevalence of meniscal tears by age and gender in accordance with the pattern of tear. In men, the prevalence of horizontal tears, complex tears, and complete macerations increased significantly with age. However, the difference in accordance with age was not statistically significant for radial tears, root tears, and vertical tears. In women, the prevalence of complex tears, root tears, and complete macerations increased significantly with age. However, horizontal tears, radial tears, and vertical tears did not show statistically significant differences with age. In women, the prevalence of horizontal tears was 30.6% among those who aged 40–49 years, which was almost twice as high as the corresponding prevalence observed among men. In participants who aged 60–69 years, the prevalence of complex tears was 14.1% for men but 45.7% for women. For root tears, men had a prevalence of 9.4%, whereas women had a prevalence of 25.9%.

### 3.3. The distribution of meniscal tears by site and pattern

Table 3 shows the distribution of meniscal tears by the site and pattern. In addition, Fig. 1 shows the detailed location of meniscus tears by age groups. The prevalence of medial meniscal tears was higher than that of lateral meniscal tears for all tear patterns. For medial tears, posterior meniscus tears showed a higher prevalence than anterior tears among both genders.

### 3.4. Associations between potential risk factors and meniscal tears

Table 4 shows the relationship between potential risk factors and meniscal tears. The prevalence of meniscal tears was 48.7% among men and 60.1% in women ($P = 0.012$). Aging was associated with a higher prevalence of meniscal tears, with prevalence rates of 27.7%, 54.4%, and 69.9% among participants ages 40–49 years, 50–59 years, and 60–69 years, respectively ($P < 0.001$). The prevalence of meniscal tears was higher among obese participants ($P = 0.004$). Of the 89 farmers with varus knee, more than two-thirds had a meniscal tear ($P = 0.002$). The prevalence rates of meniscal tears, by CSWT, were 44.5% in the "lower than 10,000 hours group," 57.8% in

**Table 2**
Prevalence of meniscus tears by the pattern of meniscus tear, age, and gender

| Pattern of tear | Men (n = 238) | | | | | | | Women (n = 248) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 40-49 yr (n = 45) | | 50-59 yr (n = 108) | | 60-69 yr (n = 85) | | P | 40-49 yr (n = 49) | | 50-59 yr (n = 118) | | 60-69 yr (n = 81) | | P |
| | n | % | n | % | N | % | | n | % | n | % | n | % | |
| Horizontal | 7 | 15.6 | 46 | 42.6 | 36 | 42.4 | 0.002 | 15 | 30.6 | 49 | 41.5 | 40 | 49.4 | 0.114 |
| Radial | 2 | 4.4 | 6 | 5.6 | 11 | 12.9 | 0.123 | 1 | 2.0 | 6 | 5.1 | 10 | 12.3 | 0.060 |
| Complex | 1 | 2.2 | 19 | 17.6 | 12 | 14.1 | 0.024 | 1 | 2.0 | 19 | 16.1 | 37 | 45.7 | <0.001 |
| Root | 1 | 2.2 | 5 | 4.6 | 8 | 9.4 | 0.251 | 1 | 2.0 | 12 | 10.2 | 21 | 25.9 | <0.001 |
| Vertical tear | 1 | 2.2 | 3 | 2.8 | 1 | 1.2 | 0.848 | 1 | 2.0 | 2 | 1.7 | 3 | 3.7 | 0.760 |
| Complete maceration | 3 | 6.7 | 11 | 10.2 | 20 | 23.5 | 0.010 | 2 | 4.1 | 8 | 6.8 | 25 | 30.9 | <0.001 |

*P* values were calculated according to Fisher's exact test.

**Table 3**
Distribution of tears by pattern and site

| Pattern of tear | Men (n = 238) | | | | Women (n = 248) | | | |
|---|---|---|---|---|---|---|---|---|
| | Medial tear (n = 105) | | Lateral tear (n = 33) | | Medial tear (n = 134) | | Lateral tear (n = 62) | |
| | n | % of men | N | % of men | n | % of women | n | % of women |
| Horizontal tear | 86 | 36.1 | 22 | 9.2 | 94 | 38.0 | 46 | 18.5 |
| Radial tear | 17 | 7.1 | 8 | 3.4 | 14 | 5.6 | 11 | 4.4 |
| Vertical tear | 4 | 1.7 | 1 | 0.4 | 6 | 2.4 | 2 | 0.8 |
| Complex tear | 28 | 11.8 | 17 | 7.1 | 53 | 21.4 | 29 | 11.7 |
| Root tear | 14 | 5.9 | 4 | 1.7 | 34 | 13.7 | 14 | 5.6 |
| Complete maceration | 31 | 13.0 | 14 | 5.9 | 31 | 12.5 | 24 | 9.7 |
| All | 105 | 44.1 | 33 | 13.9 | 134 | 54.0 | 62 | 25.0 |

A participant could have multiple tear patterns at tears at more than one site.

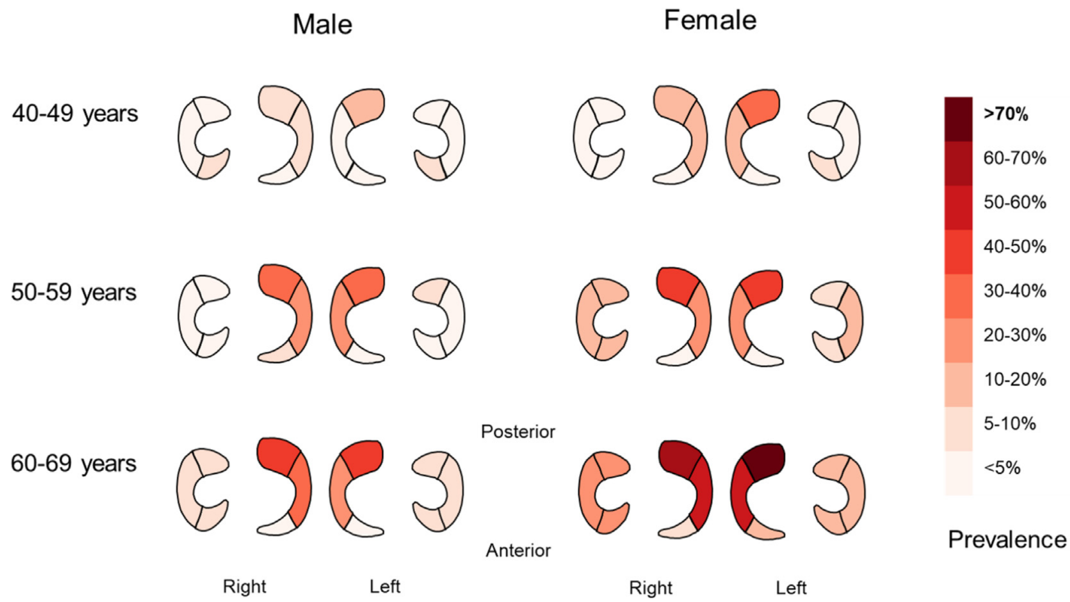


**Fig. 1.** Prevalence by the site of meniscal tears.

the “10,000–19,999 hours group,” and 66.3% in the “greater than 20,000 hours group” ($P < 0.001$). The presence of a previous knee injury history ($P = 0.990$) and CLWT ($P = 0.706$) were not significantly associated with meniscal tears.

### 3.5. *Odds ratios for meniscal tears via multiple binary logistic regression*

Table 5 shows associations between meniscal tears and potential risk factors, after covariate adjustment. Women showed greater vulnerability to meniscal tear development than men (OR = 1.61, 95% CI: 1.08–2.41). The prevalence of tears tended to increase with age (50–59 years, OR = 3.10, 95% CI: 1.80–5.36; 60–69 years, OR = 6.46, 95% CI: 3.55–11.76). The risk of meniscal tear development increased with increasing BMI (OR = 1.90, 95% CI: 1.27–2.86). A relationship was identified between meniscal tears and CSWT, which is an important factor in farming (“10,000–19,999 working hours,” OR = 2.16, 95% CI: 1.14–4.07, “≥20,000 working hours,” OR = 2.35, 95% CI: 1.45–3.80). Lower limb alignment, knee injury history, and CLWT were not statistically significantly related to meniscal tears.

**Table 4**
Associations between potential risk factors and meniscal tears

| Variables | | Total (n) in group | Meniscal tear | | |
|---|---|---|---|---|---|
| | | | N | % | *P* |
| Gender | Men | 238 | 116 | 48.7 | 0.012 |
| | Women | 248 | 149 | 60.1 | |
| Age (years) | 40-49 | 94 | 26 | 27.7 | <0.001 |
| | 50-59 | 226 | 123 | 54.4 | |
| | 60-69 | 166 | 116 | 69.9 | |
| BMI | <25 (kg/m$^2$) | 273 | 133 | 48.7 | 0.004 |
| | ≥25 (kg/m$^2$) | 213 | 132 | 62.0 | |
| Mechanical axis | Valgus | 38 | 15 | 39.5 | 0.002 |
| | Neutral | 359 | 188 | 52.4 | |
| | Varus | 89 | 62 | 69.7 | |
| Previous knee injury | No | 341 | 186 | 54.5 | 0.990 |
| | Yes | 145 | 79 | 54.5 | |
| CLWT (hours) | <2,000 | 156 | 81 | 51.9 | 0.706 |
| | 2,000–4,999 | 59 | 32 | 54.2 | |
| | ≥5,000 | 271 | 152 | 56.1 | |
| CSWT (hours) | <10,000 | 238 | 106 | 44.5 | <0.001 |
| | 10,000–19,999 | 64 | 37 | 57.8 | |
| | ≥20,000 | 184 | 122 | 66.3 | |

*P* values were collected via Chi-square tests.
BMI, body mass index; CSWT, cumulative squatting working time; CLWT, cumulative heavy-lifting working time.

## 4. Discussion

The prevalence of meniscal tears was observed to be 54.5% (men: 48.7%, women: 60.1%). An MRI study of 295 asymptomatic athletes (age range: 14–66 years, mean age: 31.2 years) reported that the overall prevalence of meniscal tears defined as a signal extending to an articular surface was 3.9% [21]. Englund et al. [8] presented a study about meniscal tears among middle-aged and elderly people in the general population. Of the 991 subjects, 57% were women, and 93% were white. The mean age was 62.3 years (range, 50.1 to 90.5 years). In the overall sample, the prevalence of meniscal damage, defined as meniscal tears or destruction in the right knee, was 35%. Among participants who aged 50 to 59 years, the prevalence of meniscal damage was 32% in men and 19% in women [8]. Unlike study of Englund et al. [8], the prevalence of meniscal damage in our study was higher in women than in men. These results seem to suggest that female farmers were exposed to more intensive physical loads.

Tables 4 and 5 indicate that women are more susceptible than men to meniscal tears (OR = 1.61, 95% CI: 1.08–2.41). Unay et al. [22] analyzed the presence of meniscal tears, as diagnosed by arthroscopy, in accordance with gender. Degenerative tears were more prevalent among women, whereas bucket-handle tears showed a stronger presence among men [22]. In rural Korean society, men and women have different roles in farming. Men are mainly responsible for rice farming, which is highly mechanized, whereas women are involved in dry-field farming, which is labor-intensive [23].

In this study, age was positively associated with meniscal tears, showing a dose–response relationship. Snoeker et al. [13] indicated that age was a major risk factor for meniscal knee tears. Englund

**Table 5**
Odds ratios of meniscal tears by multiple binary logistic regression

| Variables | | Meniscal tear | | | |
|---|---|---|---|---|---|
| | | Unadjusted OR | 95% CI | Adjusted OR | 95% CI |
| Gender | Men | 1 | | 1 | |
| | Women | 1.58 | 1.11–2.27 | 1.61 | 1.08–2.41 |
| Age (years) | 40-49 | 1 | | 1 | |
| | 50-59 | 3.12 | 1.85–5.27 | 3.10 | 1.80–5.36 |
| | 60-69 | 6.07 | 3.46–10.63 | 6.46 | 3.55–11.76 |
| BMI | $<25$ (kg/m$^2$) | 1 | | 1 | |
| | $\geq 25$ (kg/m$^2$) | 1.72 | 1.19–2.47 | 1.90 | 1.27–2.86 |
| Mechanical axis | Valgus | 0.59 | 0.30–1.17 | 0.55 | 0.27–1.14 |
| | Neutral | 1 | | 1 | |
| | Varus | 2.09 | 1.27–3.43 | 1.46 | 0.84–2.51 |
| Knee injury history | No | 1 | | 1 | |
| | Yes | 1.00 | 0.68–1.47 | 1.13 | 0.73–1.75 |
| CLWT (hours) | $<2,000$ | 1 | | 1 | |
| | 2,000–4,999 | 1.10 | 0.60–2.00 | 0.99 | 0.51–1.94 |
| | $\geq 5,000$ | 1.18 | 0.80–1.76 | 0.76 | 0.47–1.24 |
| CSWT (hours) | $<10,000$ | 1 | | 1 | |
| | 10,000–19,999 | 1.71 | 0.98–2.98 | 2.16 | 1.14–4.07 |
| | $\geq 20,000$ | 2.45 | 1.65–3.65 | 2.35 | 1.45–3.80 |

OR, odds ratio; CI, confidence interval; CSWT, cumulative squatting working time; CLWT, cumulative heavy-lifting working time; BMI, body mass index.

et al. [8] showed that incidental meniscal damage increases with increasing age in the general population. Like prevalence, the incidence of meniscal injury increases with age. In a study that observed 12.1 million person-years for the United States military service members, the incidence of meniscal tears increased with age, and those older than 40 years experienced injuries more than 4 times as often as those under 20 years [24]. As meniscal tear development is multifactorial, the number of exposure opportunities increases with age, causing meniscal tears to occur more frequently.

The present study showed that higher BMI values have a negative effect on meniscal tears. The presence of a load on the knee for long periods can adversely affect the meniscus. A previous study focusing on the effect of BMI on meniscal tears showed that the risk was higher in the obese group than in the controls, and a dose–response relationship was identified [25]. An Osteoarthritis Initiative study indicated that a higher BMI was associated with meniscal and cartilage abnormalities, with obese participants likelier to have a greater number of meniscal lesions [26]. Our results support that of previous studies focusing on the effect of BMI on meniscal tear development.

The presence of a previous knee injury history was not significantly associated with meniscal tears in our study, although knee injury is an established cause of meniscal tears. Several studies have confirmed that a high prevalence of meniscal tears in soldiers [24]. This study should be interpreted in consideration of the fact that data on knee injury history were collected by participants' recall, and information on injury intensity was insufficient.

Tables 2 and 3 show that the majority of meniscal tears were of a degenerative pattern, including horizontal tears, complex tears, and complete macerations. Horizontal tears were approximately twice as prevalent among women as among men within the 40–49 year age group, and female farmers may have developed early meniscal degeneration compared with male farmers. Fig. 1 showed that posterior tears were more prevalent than anterior tears. These results suggest that knee flexion posture is an important factor affecting meniscal degeneration.

In this study, whole meniscal tears were associated with CSWT. The correlation coefficient between age and CSWT was 0.176 ($P = 0.004$). In women, the correlation coefficient was 0.321, while we did not observe a significant correlation among men. Previous studies have already identified squatting as a major risk factor for knee osteoarthritis [27–29]. Like in the case of knee osteoarthritis, the presence of a load on the knee joint can be assumed to be a possible risk factor for meniscal tears. A study using cadavers showed that the load increases dramatically when the knee is flexed between 90° and 120° [30]. A study of miners indicated that squatting and kneeling contribute to meniscal tear development [31].

Interestingly, CLWT was not statistically significantly associated with meniscal tears. A study showed that the OR for the association between lifetime lifting and knee osteoarthritis among weight-lifting workers was 1.00 (95% CI 1.00–1.01) [27]. In this study, age and CLWT did not show a statistically significant correlation. However, CLWT and CSWT showed a significant correlation ($r = 0.633$), showing that in many cases, squatting posture and manual lifting were performed simultaneously. Baker et al. [28] reported no significant relationship between weight-lifting work and meniscal tear development. In a large scale cohort study of airport baggage handlers, only weight-lifting work was not sufficient to cause meniscal tears; the risk increased if the weight-lifting work was combined with squatting or kneeling [15]. A reasonable hypothesis is that weight-lifting alone does not have a significant effect on the meniscus; however, in combination with other types of work, it may affect meniscal tear development.

This study had some limitations. First, all the participants were selected from the KFKC cohort, except those who had already reached the terminal stage of knee osteoarthritis. In the past decade, the prevalence of total knee arthroplasty has dramatically increased by up to 407% in Korea [32]. This phenomenon may have caused many cases of late-stage knee osteoarthritis to be excluded from the study. In addition, farming is a strenuous job. Therefore, the OR of the highest CSWT group may have been underestimated by selection bias or the healthy worker effect [33]. Second, this study assessed the risk of meniscal tears by distinguishing between low and high exposure groups among farmers. Thus, these results could not present comparisons between farmers and participants from the general population or within other occupations. Third, participants' answers pertaining to the presence of previous knee injuries and past working time may have recall errors. Fourth, gender-specific analysis may be necessary because of large differences in biological and work methods between men and women. However, limited sample size in this study made it difficult to have adequate power for gender-specific analysis. Therefore, we could not attempt this analysis. Fifth, farmers can take a squat position even when doing housework. However, this study did not collect information on housework. Sixth, most of the study subjects were complex farmers who grow two or more crops, and the types of crops were varied and heterogeneous. Therefore, it was difficult to attempt analysis by the category of primary work.

The strengths of the present study are as follows. First, this study was based on imaging data from bilateral knee MRI analyses. To our knowledge, few studies have researched meniscal knee tears using MRI within specific occupational groups. Second, we quantitatively investigated various work-related factors among farmers and revealed the presence of an association between farming and meniscal tears, after adjustment for major variables. Third, this study provides detailed information on the pattern and the site of meniscal tears in physical workers.

## 5. Conclusion

The present study found that female gender, older age, obesity, long work shifts, and a prolonged squatting posture at work was associated with meniscal tears. The higher OR for meniscal tears in accordance with prolonged squatting work posture and female gender are consistent with the high prevalence of knee osteoarthritis in female farmers. In addition, our results suggest the importance of early diagnosis and prevention programs with regard to knee osteoarthritis among female farmers.

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## Conflicts of interest

All authors have no conflicts of interest to declare.

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