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ORIGINAL ARTICLE

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Influence of the type of occupation on osteoarthritis of the knee in men: The Korean National Health and Nutrition Examination Survey 2010-2012

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Abstract

Objectives: We investigated the influence of different types of lifetime occupation on knee osteoarthritis (OA) and pain based on a nationwide survey in Korea.

Methods: We conducted a cross-sectional study using Korea National Health and Nutrition Examination Survey (KNHANES) from 2010 to 2012. Men ≥50 years old were divided into four occupational groups: white-collar (WC) workers, pink-collar (PC) workers, blue-collar (BC) workers, and agribusiness and low-level (AL) workers. The risks for knee OA and pain development according to occupation were compared to the risks in WC workers, using multiple logistic regression analyses.

Results: Different occupations were associated with different levels of risk for knee OA and knee pain. The risk for knee OA was higher in BC workers and in AL workers than in WC workers, in order of higher risk. The risk for severe knee OA was likewise higher in AL workers and in BC workers, in order of higher risk. The risk for chronic knee pain was higher in AL workers, BC workers, and PC workers, in order of higher risk. The risk for moderate to severe chronic knee pain was higher in AL workers and BC workers, in order of higher risk.

Conclusions: The results suggest that occupation might affect the development of knee OA and presence of chronic knee pain in men ≥50 years old. WC workers are least affected by knee OA and chronic knee pain, and AL and BC workers are at clearly higher risk for knee OA and chronic knee pain.

KEYWORDS

knee osteoarthritis, occupations, osteoarthritis, pain, physical activity

1 | INTRODUCTION

Knee pain is a common musculoskeletal complaint in elderly populations. Its prevalence is approximately 25% in older adults.[1] It limits daily activities, deteriorates the quality of life, and also causes a great deal of socioeconomic expense.[2,3] Knee osteoarthritis (OA) is a main cause of knee pain, and it is particularly serious in old age.[4] Prolonged knee pain is generally related to knee OA.[5]

Knee OA is a degenerative disease of the knee joint that progresses with age. It is also affected by physical loads, as it is commonly seen in obese people.[6-8] However, physical loadings could also be affected by other factors, such as physical activities. Occupation is one of the crucial factors that

determine physical loading and other environmental factors throughout a lifetime.[9] Kellgren et al reported that knee OA was more prevalent in miners than in office or manual workers.[10] Kivimaki et al reported that knee pain and knee OA were more frequently observed in carpet and floor layers, who kneeled during work.[11] Seidler et al, in a population-based case-control study, verified that more frequent kneeling and squatting movements during work were associated with higher risk for knee OA.[12]

However, previous studies have focused on the relationship between specific occupation and knee OA with small sample size. To the best of our knowledge, few studies have examined the association between types of occupation and knee OA in general population. This has limited the general applicability of previous findings on this issue. In our present study therefore, we investigated the influence of types of lifetime occupations on knee OA and knee pain using a nationwide survey in Korea.

2 | MATERIALS AND METHODS

2.1 | Data sources and study population

The data used in this study were obtained from the Korea National Health and Nutrition Examination Surveys (KNHANES) V, conducted from 2010 to 2012 by the Korea Centre for Disease Control and Prevention (KCDC).[13] The KNHANES, which are cross sectional, national surveys with representative samples of a noninstitutionalised civilian Korean population, assessed the health and nutritional status of Koreans. It is composed of three parts: a health interview, health examinations, and nutrition surveys. All subjects were randomly selected using a stratified, multistage, probability sampling method with proportional allocation based on geographic area, sex, and age.

We selected men ≥50 years old (n = 4376) from the pool of subjects. Of these, 4064 participants who had radiographs of their knees were enrolled in our study. In all, 3988 participants reported knee pain on the questionnaire. All filled out informed consent. The institutional review board (IRB) of our hospital approved the study (IRB No. 2016-0643).

2.2 | Classification of occupation

Subjects were classified into nine occupational subgroups according to longest-lasting occupations they had ever had, based on the major classifications of the 6th Korean Standard Classification of Occupations (KSCO).[14] The KSCO was devised using the International Standard Classification of Occupations (ISCO) in 1963 and again revised on the basis of the ISCO-08 at 2007. Occupations were re-categorised into four groups[9,15,16]: white-collar (WC) workers included managers, professionals, and office workers; pink-collar (PC) workers included service and sales workers; blue-collar (BC) workers included technicians and device and machine operators; and agribusiness and low-level (AL) workers included skilled workers in agriculture and fishery and low-level laborers. Homemakers, soldiers, and the unemployed were excluded.

2.3 | Assessment of the knee OA

Participants aged ≥50 years underwent knee radiography for routine examinations. Plain anterior-posterior and lateral radiographs of the knee were taken using an SD 3000 Synchro Stand (AcceleRay SYFM Co., Seoul, Korea). The film was centered 1 cm below the patella apex for radiographs of the anterior-posterior and lateral views, according to the standard protocol. The radiographs were evaluated by two radiologists to determine the presence of knee OA according to the Kellgren-Lawrence grading system.[17] The system has five grades, as follows: Grade 0, normal; Grade 1, minute osteophyte; Grade 2, definite osteophyte; Grade 3, moderate joint space narrowing and definite osteophyte; and Grade 4, severe joint space narrowing with subchondral sclerosis. Knee OA was defined as a Kellgren-Lawrence grade ≥2. Severe knee OA was defined as a grade of 3 or 4.[18]

2.4 | Assessment of knee pain

Knee pain was evaluated as present if participants answered "Yes" to the question, "Have you ever experienced knee pain for more than 30 days during the last 3 months?" Participants who had knee pain reported the severity of pain on a numeric rating scale (NRS) from 0 to 10. The severity of knee pain was subdivided into four levels, according to previous studies[19,20]: 0 = no pain, 1-3 = mild, 4-6 = moderate, and 7-10 = severe. Moderate to severe knee pain was defined as an intensity of knee pain ≥4.

2.5 | Assessment of environmental factors

To assess the other possible contributing factors, we included age, obesity, education, house income, alcohol consumption, smoking, and physical activity (PA) in the analysis. Subjects were classified into four age groups: 50-59, 60-69, 70-79, and ≥80 years old. Obesity was defined as body mass index ≥25 kg/m^2, according to the cut-off value for the Asia-Pacific region.[21,22] Education level was divided into "college or higher" and "high school or less." The quartiles of household income were designated as "high," "average to high," "average to low," and "low" in the survey. Alcohol consumption was divided into "drinking less than once a month" and "drinking once or more than once a month." Smoking status was

categorised into two groups, "non or ex-smoker" and "current smoker." The PA of participants was assessed using the Korean version of the International Physical Activity Questionnaire-Short Form (IPAQ-SF). This questionnaire consists of questions on the frequency, duration, and intensity of recent PA.[23,24] PA was defined as the actual practice of each exercise: vigorous PA, vigorous activity of at least 20 minutes on 3 days or more per week; moderate PA, moderate-intensity activity at least 30 minutes on 5 days or more per week; walking PA, more than 30 minutes of walking on 5 days or more per week. Vigorous activity refers to activities that take hard physical effort with breathing much harder than normal like jogging, climbing, fast biking, fast swimming, jumping rope, single tennis, or carrying heavy object. Moderate-intensity activity refers to activities that take moderate physical effort with breathing somewhat harder than normal like slow swimming, double tennis, volleyball, badminton, ping-pong, or carrying light object. Furthermore, strength and flexibility PA were defined as strength and flexibility exercises 2 days or more per week.

2.6 | Statistical analysis

Multivariate logistic regression analyses were performed to evaluate the factors contributing to knee OA, severe knee OA, chronic knee pain, and moderate to severe knee pain. Odds ratios (ORs) were calculated according to the corresponding 95% confidence intervals (CIs). Model 1 was adjusted according to age, obesity, and occupation. Model 2 was adjusted according to age, obesity, occupation, and other environmental factors, including education, house income, alcohol consumption, smoking, and PA. Sampling weights were applied to each participant's data to represent the Korean population without biased estimates. SAS version 9.4 was used for statistical analyses (SAS Institute, Cary, NC).

3 | RESULTS

3.1 | Demographic features of the study subjects

The prevalence of knee OA, severe knee OA, knee pain, and moderate to severe knee pain in our study population was 21.14% (n = 1012), 9.1% (n = 443), 11.2% (n = 488), and 8.6% (n = 377) (Supplementary Table S1). The demographic features of the subjects according to the presence or absence of knee OA are presented in Table 1. The incidence of knee OA increased with age and in terms of occupation, the WC group had the lowest frequency of knee OA with other groups showing a higher incidence in the order PC, BC, and AL (Supplementary Table S2).

3.2 | Association between occupation and the risk of knee OA

In univariate analyses, occupation was correlated with risk for knee OA. Higher ORs) were found in BC workers (OR, 1.423, 95% CI, 1.10-1.85) and AL workers (OR, 1.909, 95% CI, 1.47-2.48) than in WC workers. After adjusting for age, obesity, and occupation (model 1), higher ORs were observed in BC workers (adjusted OR, 1.652, 95% CI, 1.26-2.17) and AL workers (adjusted OR, 1.580, 95% CI, 1.21-2.07). After adjusting for all possible confounding factors (model 2), a high OR was observed only in BC workers (adjusted OR, 1.457, 95% CI, 1.06-2.01) (Table 2).

3.3 | Association between occupation and the risk of severe knee OA

In univariate analyses, risk for severe knee OA tended to be higher in BC workers (adjusted OR 1.570, 95% CI, 1.09-2.26) and AL workers (adjusted OR, 2.60, 95% CI, 1.83-3.70) than in WC workers. A similar tendency was observed in models 1 and 2, after adjusting for confounding factors. The risk for severe knee OA tended to remain higher in BC workers (adjusted OR, 1.839, 95% CI, 1.26-2.68 in model 1, and adjusted OR 1.839, 95% CI, 1.21-2.80 in model 2) and AL workers (adjusted OR, 2.089, 95% CI, 1.46-2.99 in model 1, and adjusted OR, 1.946, 95% CI, 1.33-2.90 in model 2) (Table 3).

3.4 | Association between occupation and the risk of chronic knee pain

In univariate analyses, chronic knee pain was found to be more frequent in AL workers (adjusted OR, 3.91, 95% CI, 2.80-5.46), BC workers (adjusted OR, 2.208 95%, CI, 1.53-3.18), and PC workers (adjusted OR, 2.040, 95% CI, 1.28-3.25) than in WC workers. In models 1 and 2, these tendencies were constantly observed. The greatest frequency was observed in AL workers (adjusted OR, 3.550, 95% CI, 2.53-4.97 in model 1, and adjusted OR, 2.761, 95% CI, 1.80 4.24 in model 2). Higher frequencies were observed in BC workers (adjusted OR, 2.319, 95% CI, 1.61-3.34 in model 1, adjusted OR, 1.912%, and 95% CI, 1.22-2.99 in model 2) and PC workers (adjusted OR, 2.066, 95% CI, 1.29-3.31 in model 1, and adjusted OR, 1.7895%, CI, 1.05-3.07 in model 2) (Table 4).

3.5 | Association between occupation and the risk of moderate to severe chronic knee pain

Unlike chronic knee pain, moderate to severe chronic knee pain increased only in BC and AL workers. PC workers showed a tendency to have more moderate to severe chronic knee pain than WC workers, but this was not statistically significant. In univariate analyses, higher ORs

TABLE 1 Demographic characteristics of the study subjects

	No knee OA (n = 3052),	Knee OA[a] (n = 1012),	Total (n = 4064),
	No. (%)	No. (%)	No. (%)
Age			
50-59	1275 (56.97)	161 (26.65)	1436 (50.56)
60-69	1048 (27.17)	337 (33.39)	1385 (28.49)
70-79	639 (13.58)	413 (31.43)	1052 (17.35)
≥80	90 (2.28)	101 (8.53)	191 (3.60)
Occupation			
WC workers	918 (27.99)	214 (20.27)	1132 (26.35)
PC workers	409 (14.82)	111 (12.61)	520 (14.35)
BC workers	858 (33.92)	292 (34.96)	1150 (34.14)
AL workers	698 (23.26)	346 (32.16)	1044 (25.16)
Alcohol			
<Once a month	924 (29.01)	360 (32.36)	1284 (29.74)
≥Once a month	2014 (70.99)	613 (67.64)	2627 (70.28)
Smoking			
Non- or ex-smoker	1958 (62.55)	719 (69.07)	2677 (63.93)
Current smoker	985 (37.45)	257 (30.93)	1242 (36.07)
Obesity			
Absent	2153 (69.18)	633 (60.79)	2786 (67.40)
Present	892 (30.82)	378 (39.21)	1270 (32.60)
Education			
≤High school	2318 (80.87)	863 (89.02)	3181 (82.60)
>High school	627 (19.13)	116 (10.98)	743 (17.40)
House income			
High	806 (28.73)	152 (17.98)	958 (26.46)
Average to high	696 (24.11)	173 (20.73)	869 (23.39)
Average to low	784 (25.45)	265 (25.74)	1049 (25.51)
Low	723 (21.71)	406 (35.55)	1129 (24.64)
Vigorous PA[b]			
Absent	2488 (83.91)	843 (85.03)	3331 (84.14)
Present	450 (16.09)	132 (14.97)	582 (15.86)
Moderate PA[c]			
Absent	2686 (91.02)	870 (89.49)	3556 (90.69)
Present	255 (8.98)	104 (10.52)	359 (9.31)
Walking[d]			
Absent	1728 (60.33)	530 (53.96)	2258 (58.98)
Present	1209 (39.67)	443 (46.04)	1652 (41.02)
Strength exercises[e]			
Absent	2260 (77.83)	760 (78.26)	3020 (77.92)
Present	683 (22.17)	214 (21.74)	897 (22.08)

(Continues)

were observed in BC workers (adjusted OR, 2.897, 95% CI, 1.88-4.39) and AL workers (adjusted OR, 5.104, 95%, CI, 3.46-7.54) than in WC workers. After adjusting for confounding factors in models 1 and 2, similar results were observed: higher ORs were observed in BC workers (adjusted OR, 3.047, 95% CI, 2.00-4.65 in model 1, and adjusted OR, 2.504, 95% CI, 1.51-4.15 in model 2) and AL workers (adjusted OR, 4.548, 95% CI, 3.08-6.72 in model

TABLE 1 (Continued)

	No knee OA (n = 3052),	Knee OA[a] (n = 1012),	Total (n = 4064),
	No. (%)	No. (%)	No. (%)
Flexibility exercises[f]			
Absent	1765 (61.41)	627 (65.37)	2392 (62.25)
Present	1178 (38.59)	347 (34.63)	1525 (37.75)

Values are expressed as numbers (%).
Sampling weights were applied to the data for each subject.
OA, osteoarthritis; CI, confidence interval; OR, odds ratio, PA, physical activity; WC, white-collar; PC, pink-collar; BC, blue-collar; AL skilled agribusiness and fishery workers and low-level laborers.
[a]Knee OA is Kellgren-Lawrence grade ≥2.
[b]Vigorous PA: at least 20 minutes of vigorous activity three or more days per week.
[c]Moderate PA: at least 30 minutes of moderate-intensity activity five or more days per week.
[d]Walking: at least 30 minutes of walking five or more days per week.
[e]Strength exercises: exercises performed two or more days per week.
[f]Flexibility exercises: exercises performed two or more days per week.

TABLE 2 Odds ratios for knee OA

	Univariate analysis		Model 1[a]		Model 2[b]	
Occupation	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
WC workers	Reference		Reference		Reference	
PC workers	1.175	0.872-1.583	1.213	0.880-1.671	1.060	0.744-1.512
BC workers	1.423	1.096-1.848	1.652	1.256-2.174	1.457	1.055-2.010
AL workers	1.909	1.473-2.476	1.580	1.205-2.073	1.320	0.966-1.805

OA, osteoarthritis; CI, confidence interval; OR, odds ratio; WC, white-collar; PC, pink-collar; BC, blue-collar; AL, skilled agribusiness and fishery workers and low-level laborers.
$P < 0.05$ was considered statistically significant.
[a]Model 1 was adjusted for age and obesity.
[b]Model 2 was adjusted for age, obesity, education, house income, alcohol consumption, smoking, and physical activity.

TABLE 3 Odds ratios for severe knee OA

	Univariate analysis		Model 1[a]		Model 2[b]	
Occupation	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
WC workers	Reference		Reference		Reference	
PC workers	1.129	0.709-1.800	1.163	0.724-1.869	1.189	0.710-1.992
BC workers	1.570	1.091-2.258	1.839	1.262-2.680	1.839	1.210-2.795
AL workers	2.600	1.827-3.701	2.089	1.460-2.988	1.946	1.328-2.851

OA, osteoarthritis; CI, confidence interval; OR, odds ratio; WC, white-collar; PC, pink-collar; BC blue-collar, AL, skilled agribusiness and fishery workers and low-level laborers.
$P < 0.05$ was considered statistically significant.
[a]Model 1 was adjusted for age and obesity.
[b]Model 2 was adjusted for age, obesity, education, house income, alcohol consumption, smoking, and physical activity.

1, and adjusted OR, 3.589, 95% CI, 2.23-5.77 in model 2) (Table 5).

3.6 | Association between other factors and knee OA/chronic knee pain

The OR of obesity for knee OA was 1.821 (95% CI, 1.48-2.24) in model 1 and 1.760 (95% CI, 1.42-2.18) in model 2. In contrast, there was no significant association found between obesity and chronic knee pain (OR, 1.194, 95% CI, 0.91-1.57 in model 1, and OR, 1.207, 95% CI, 0.91-1.60 in model 2) or moderate to severe chronic knee pain (OR, 1.215, 95% CI, 0.90-1.64 in model 1, and OR, 1.271, 95% CI, 0.93-1.73 in model 2) (Supplementary Table S3). There was also no significant association found between current PA and knee OA or severe knee OA.

TABLE 4 Odds ratios for chronic knee pain

	Univariate analysis		Model 1[a]		Model 2[b]	
Occupation	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
WC workers	Reference		Reference		Reference	
PC workers	2.040	1.282-3.246	2.066	1.290-3.307	1.797	1.052-3.067
BC workers	2.208	1.533-3.179	2.319	1.609-3.342	1.912	1.224-2.989
AL workers	3.910	2.801-5.457	3.550	2.533-4.974	2.761	1.798-4.238

WC, white-collar; CI, confidence interval; OR, odds ratio; PC, pink-collar; BC, blue-collar; AL, skilled agribusiness and fishery workers and low-level laborers.
$P < 0.05$ was considered statistically significant.
[a]Model 1 was adjusted for age and obesity.
[b]Model 2 was adjusted for age, obesity, education, house income, alcohol consumption, smoking, and physical activity.

TABLE 5 Odds ratios for moderate to severe chronic knee pain

	Univariate analysis		Model 1[a]		Model 2[b]	
Occupation	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
WC workers	Reference		Reference		Reference	
PC workers	1.666	0.964-2.879	1.686	0.975-2.916	1.405	0.781-2.530
BC workers	2.879	1.886-4.393	3.047	1.995-4.652	2.504	1.510-4.152
AL workers	5.104	3.457-7.536	4.548	3.076-6.722	3.589	2.232-5.774

WC, white-collar; CI, confidence interval; OR, odds ratio; PC, pink-collar; BC, blue-collar; AL, skilled agribusiness and fishery workers and low-level laborers.
$P < 0.05$ was considered statistically significant.
[a]Model 1 was adjusted for age and obesity.
[b]Model 2 was adjusted for age, obesity, education, house income, alcohol consumption, smoking, and physical activity.

However, walking showed an inverse relationship to knee pain (OR, 0.749, 95% CI, 0.57-0.98 in model 2) and moderate to severe knee pain (OR, 0.659, 95% CI, 0.50-0.87 in model 2) (Supplementary Table S3).

4 | DISCUSSION

Our current study findings indicate that lifetime occupation may affect the occurrence of knee OA. BC and AL workers, who were exposed to higher workloads, were at higher risk for knee OA than workers with lower physical workloads, such as WC and PC workers. These findings were also seen after adjusting for confounding variables. Knee pain had a similar tendency, being more strongly associated with AL, BC, and PC workers, in order of increasing risk, than in WC workers.

4.1 | Knee OA and occupation

Previous studies have reported a correlation between specific occupation and knee OA or knee pain.[10,11] The risk for knee OA is higher in occupations requiring heavy work loading, or demanding movements that put a burden on the knee, such as kneeling or squatting.[11] Seidler (2008) reported that there was a dose-response relationship between these movements and the development of knee OA.[12]

Like previous studies, our present study showed that the risk for knee OA varies according to occupational group. BC and AL workers, who perform more physical labor, showed more frequent knee OA than PC and WC workers. In severe knee OA, this difference became more obvious. The risk for severe knee OA was highest in AL workers, who do the most strenuous labor. This suggests that occupational physical demand might affect the development of knee OA. As in previous studies, not only overall physical loading but also specific movements may have an effect. WC workers are commonly exposed to static sitting postures, whereas PC workers are exposed to long periods of standing. BC workers may be exposed to some degree of bending, squatting, and lifting. AL workers may be exposed to heavy lifting and bending, squatting, and kneeling.[9,25] It may be that PC workers are not severely exposed to specific actions or physical loadings that could increase knee OA.

The difference in the risk for developing knee OA according to occupation might be due not only to physical loading but also other factors that may cause knee OA, such as exercise, hobbies, diet, and living environment. In this study, however, detailed information for these factors was not available. The analysis could not be conducted for several environmental factors. Further research is needed to identify the fundamental causes of the occupational difference in risk for knee OA.

Although previous studies have evaluated the development of knee OA according to occupation, they have focused

only on several specific occupations, and no studies have analysed the overall risk for knee OA according to entire occupational groups, as in this study. Our results may be helpful for predicting, preventing, and treating knee OA in the work place as well as clinical settings.

4.2 | Chronic knee pain and occupation

Risk for chronic knee pain was highest in the AL group, followed by BC and PC workers, similar with the order of the risk for knee OA. Furthermore, the OR for moderate to severe chronic knee pain was even higher in BC and AL workers than that of chronic knee pain. This suggests that occupation plays an important role in the development of clinically significant knee pain. In our current study, the ORs for chronic knee pain according to occupation were higher than those for knee OA. This may occur because knee pain can develop not only from knee OA but also from various pathologies, such as meniscus tear, tendinopathy, and ligament sprain; these may also be affected by occupational differences.[26] In addition, the occurrence of knee pain can be affected by recent daily activities, exercise, and lifestyle as well as by underlying knee pathologies[27]; it would be possible for there to be a difference in the occurrence of knee OA and that of knee pain. These results correspond with the result that the OR of model 2, which was adjusted by environmental factors including PAs, was lower than that of model 1. The risks for chronic knee pain and moderate to severe knee pain in AL workers were markedly higher than in the other groups. This result might be caused by the tendency of AL workers to work even in their old age.

4.3 | Effects of other factors on the occurrence of knee OA and chronic knee pain

Obesity is well known to increase the risk of developing knee OA and severe knee OA.[6-8] The ORs of obesity for knee OA and severe knee OA were higher than those of non-obesity in our analysis. However, the risks of chronic knee pain and moderate to severe knee pain were not significantly increased among obese subjects. These differences between knee OA and pain may be due to differences in lifestyle. It has been suggested that a sedentary lifestyle in obese people may attenuate the risk of knee pain.[28,29] In our current study subjects, there was also no significant association found between current PA and either knee OA or severe knee OA. Walking showed an inverse correlation with knee pain and moderate to severe knee pain in our study cohort which is concordant with previous observations that walking prevents knee pain.[30] However, it is possible also that the frequency of walking activities may decrease if there is knee pain. This may be a limitation of this study as a cross-sectional study, namely, a limitation to its ability to identify causal relationships. Further prospective, longitudinal studies are needed to determine causes.

4.4 | Prevalence of knee OA

Dilon et al have reported a 31.2% prevalence of radiologic knee OA in men aged above 60 years in a previous US-based population study.[31] In our current study in a Korean population, the prevalence of radiographic knee OA was measured at 25.04% in men aged 50 years and above. However, when we estimated this in the men aged ≥60, the prevalence was comparable with that described in the study of Dilon and colleagues at 32.38%. In contrast, a prior study in a Chinese population aged ≥60 from Beijing reported a radiographic knee OA prevalence of 21.5% in men.[32] The reason for this discrepancy may be due to the urban-based cohort in the Chinese study compared with the nationwide population analysed in our present report.

4.5 | Strengths and limitations

Our study had several noteworthy strengths. First, to the best of our knowledge, our current investigation is the first to assess the relationship between occupation and knee OA in a nationwide and representative, large-scale population. Second, unlike previous studies, we compared the risks for knee OA and knee pain among almost all types of occupation using the KSCO classification and not just a few specific professions. Our current findings may therefore be used in the future not only to predict and prevent knee OA and/or pain in various workplaces but also to treat these conditions in a clinical setting. Finally, we measured the degree of knee OA objectively using radiographs and in accordance with the Kellgren-Lawrence grade and subjectively assessed the severity of knee pain using a questionnaire. This approach enabled us to obtain robust and reliable results based on objective and accurate data.

There were also several limitations of our present study of note. In the first instance, it was cross sectional in design and was therefore limited in its ability to examine and explain the causal relationships between various environmental factors and knee OA. However, there are some temporal relationships between a person's longest occupation and current knee OA and/or pain. Our cross-sectional study thus had the characteristics of a cohort study. There seems to be causal relationship between the types of occupation and knee OA and/or pain. In addition, the consistency in our findings using various analytic models, adjusted by different environmental factors, indirectly indicated that occupation is a strong causal factor for knee OA. Another limitation was that occupations were subclassified into only four groups and we could not investigate the risks of knee disorders associated with specific professions. Detailed characteristics such as the frequency of certain physical movements and intensity of labor are likely to vary within each of the four occupation classes we analysed. In addition, we only used information on the longest occupation of the study subjects and did not collect data on the actual duration of this occupation or the period of time since retirement. The actual physical loadings may well have

been different within the same groups and may have been greater for certain subjects with occupations that are generally thought to be less onerous but that were undertaken for a far longer duration. Notably however, heavy workloads over a short duration might still promote the development of knee OA. Finally, although there are many advantages of using large-scale nationwide study such as KNHANES, it does not provide any data on variables that can also affect the incidence of knee OA and pain such as previous knee injuries, exercise levels, hobbies, diet, or living environment. Further knee OA cohort studies will need to accurately evaluate factors such as these in addition to occupation.

5 | CONCLUSION

The results suggest that type of occupation may affect the development of knee OA and the presence of chronic knee pain in men ≥50 years old. WC workers were least affected by knee OA and chronic knee pain, and AL and BC workers had clearly higher risks for both. In particular, the risks for severe knee OA and moderate to severe chronic knee pain were much higher in AL workers. Further prospective, cohort studies will be needed to determine the exact causalities between occupation and knee OA and pain.

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DISCLOSURE

Approval of the research: The institutional review board (IRB) of our hospital approved the study (IRB No. 2016-0643). *Informed consent*: All subjects provided written informed consent before participated in this survey (KNHANES V, 2010-2012). *Registry and the registration no. of the study/trial*: N/A. *Animal studies*: N/A. *Conflict of interest*: None declared.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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