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CLINICAL RESEARCH

# Prevalence and Risk Factors of Spine, Shoulder, Hand, Hip, and Knee Osteoarthritis in Community-dwelling Koreans Older Than Age 65 Years

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**Abstract**

*Background* Osteoarthritis (OA) is common and disabling among older patients around the world. Data exploring the prevalence and risk factors of OA are of paramount importance in establishing healthcare policies. However, few studies have evaluated these topics among Asian populations.

*Questions/purposes* This study was conducted to determine the prevalence and risk factors of radiographic OA in the spine, shoulder, hand, hip, and knee in Koreans older than age 65 years.

*Methods* A simple random sample (N = 1118) was drawn from a roster of elderly individuals older than age 65 years in Seongnam. Of the 1118 invited subjects, 696 (males = 298, females = 398) participated in this study (a response rate of 62%). The mean age of respondents was 72 ± 5 years (range, 65–91 years). Radiographs of the lumbar spine, shoulder, hand, hip, and knee were taken and afterward evaluated for radiographic OA. The Kellgren-Lawrence grading system was used for all mentioned joints, and radiographic OA was defined as Grade 2 changes or higher. The association of sex, aging, and obesity with OA in each of the mentioned joints was determined with the help of multivariate logistic regression.

*Results* The highest prevalence of radiographic OA was seen in the spine (number of subjects with OA/number of whole population = 462 of 696 [66%]) followed by the hand (415 of 692 [60%]), knee (265 of 696 [38%]), shoulder (36 of 696 [5%]), and hip (15 of 686 [2%]). Female sex was associated with knee OA (odds ratio [OR], 5.7; 95% confidence interval [CI], 3.9–8.4; $p < 0.001$) and hand OA (OR, 2.3; 95% CI, 1.6–3.1; $p < 0.001$), and male sex was associated with spine OA (OR, 0.7; 95% CI, 0.5–1.0; $p = 0.025$). Aging was associated with radiographic OA in the spine, knee, and hand (OR per 5-year increments, 1.3 [95% CI, 1.1–1.6; $p = 0.001$], 1.6 [95% CI, 1.4–1.9; $p < 0.001$], and 1.4 [95% CI, 1.2–1.7; $p < 0.001$]), respectively) but not associated with OA in the hip and shoulder. Obesity was associated with knee OA (OR, 3.4; 95% CI, 2.4–5.0; $p < 0.001$) and spine OA (OR, 1.5; 95% CI, 1.1–2.2; $p = 0.014$) but not with OA in other joints.

*Conclusions* OA of the spine, hand, and knee is likely to become a major public health problem rather than shoulder and hip OA in Korea. Associations of demographic factors

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Each author certifies that his or her institution has approved the human protocol for this investigation, and that all investigations were conducted in conformity with ethical principles of research, and that informed consent was obtained.
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with radiographic OA differed among each joint, and that would be valuable information to assess the role and influence of risk factors of OA in various joints.

*Level of Evidence* Level III, prognostic study.

## Introduction

Osteoarthritis (OA) is a major public health concern as a result of its high prevalence, its treatment costs, and its association with pain and chronic disability. Numerous efforts to identify the associations between patient factors and OA prevalence and to explore more effective remedies have been made. One method of studying OA is by epidemiology. Through epidemiologic studies, researchers can assess the role and influence of risk factors and provide valuable information to aid policymaking in national health care.

The prevalence of OA differs by country and ethnicity [1, 3, 5, 7, 10–13, 18, 22, 24, 26–28, 30, 34, 35, 39, 40]. Racial or geographical differences may provide valuable clues about potential etiologic factors. However, the majority of surveys on the prevalence of OA have been performed in Europe and the United states [1, 3, 5, 10–13, 18, 22, 28, 30, 34, 35]. Recently, a relatively small number of population-based studies have been conducted in Asia [7, 24, 26, 27, 39, 40]; therefore, racial differences in the epidemiologic characteristics of OA could be estimated in some degrees through the comparative analysis. However, most Asian population-based surveys have been limted primarily to China and Japan and have been focused on the OA of a single joint; thus, little is known about the ethnic and geographical variation of the pattern of joint distribution of OA among the same Asian populatons.

This study was conducted (1) to estimate and compare the overall and sex-specific prevalence of radiographic OA in the spine, shoulder, hand, hip, and knee in Koreans older than age 65 years; and (2) to investigate the possible association between demographic risk factors (sex, aging, and obesity) and radiographic OA in each of the mentioned joints.

## Patients and Methods

Our study is a cross-sectional analysis of a baseline database from the Korean Longitudinal Study on Health and Aging (KLoSHA). The KLoSHA was a population-based prospective cohort study of health, aging, and common geriatric diseases in elderly Koreans and was conducted from September 2005 to August 2006 on residents of Seongnam (South Korea) aged 65 years or older. Seongnam had a population of 931,019 in 2005, and of these, 61,730 (6.6%) were aged 65 years or older. A simple random sample ($n = 1118$) was drawn from a roster of elderly individuals 65 years of age or older using a computer-generated list of random numbers, and the individuals chosen were invited to participate in the study. The mean age of invitees was 73 ± 7 years (range, 65–99 years), and 701 (63%) were females. Of the 1118 invited individuals, 696 participated in this study (a response rate of 62%). The mean age of respondents was 72 ± 5 years (range, 65–91 years), and 398 (57%) were females. Respondents were younger (mean age of nonrespondents = 75 ± 8 years, $p < 0.001$, Mann-Whitney U test) and included a smaller proportion of females than nonrespondents (percentage of females within nonrespondents = 72%, $p < 0.001$, chi-square test). The mean body mass index (BMI) of respondents was 24 ± 3 kg/m$^2$. Females had a greater mean BMI than males among respondents (25 ± 3 kg/m$^2$ for females versus 24 ± 3 kg/m$^2$ for males, $p = 0.013$, Student's t-test). This study was approved by the institution review board of our hospital, and informed consent was obtained from all participants.

Radiographs of both shoulders, both hands, both knees, both hips, and the lumbar spine were taken for all participants. All radiographic images were digitally acquired using a picture archiving and communication system (PACS; Impax: Agfa, Antwerp, Belgium), and assessments were subsequently carried out using the PACS software. Radiographic severity of OA was determined for each joint using the Kellgren-Lawrence (K/L) grading system [16, 17]. All evaluations were performed using a standard atlas [16] for radiographic OA by a single investigator (HJC), who was unaware of subject identities.

The presence of radiographic OA in the lumbar spine was determined using a lateral radiograph. Its severity was assessed at each intervertebral level from L1/2 to L5/S1. We checked for the presence of osteophytes in the vertebral endplate and the narrowing of intervertebral disc space according to the K/L scale. If the radiographic grade at the most severely affected intervertebral level was K/L Grade 2 or higher, the subject was classified as having radiographic spine OA. If the subject had previously undergone surgery such as instrumentation and fusion, the operated intervertebral levels were excluded (number of individuals; L3/4 = one, L4/5 = eight, L5/S1 = two), and assessment was performed at the nonoperated intact intervertebral level.

Glenohumeral OA of the shoulder was examined using an AP radiograph. However, there have been no established criteria for radiographic glenohumeral OA. Given their general compatibility with knee K/L grades, we adapted the knee K/L grade description for glenohumeral OA. Accordingly, we rigorously checked the presence of osteophytes and the narrowing of glenohumeral articulation. If the K/L grade in one or both joints was Grade 2 or higher, the subject was considered to have radiographic shoulder OA.

Fifteen joints for each hand, including four distal interphalangeal (DIP), four proximal interphalangeal (PIP), one thumb interphalangeal (IP), five metacarpophalangeal (MCP), and first carpometacarpal (CMC) joints, were examined with posteroanterior radiograph and were evaluated for the presence of osteophytes, joint space narrowing, sclerosis, and cysts. Each hand joint was graded according to the K/L scale. We characterized a hand joint as having radiographic OA if it had a K/L Grade 2 or higher. If the subject had at least one hand joint with radiographic OA, he or she was classified as having radiographic hand OA. Two participants did not obtain hand radiographs. Individuals who had a history of trauma to the hand and whose radiographs were of poor quality as a result of the deformity (number of individuals = two) were excluded. In total, four individuals were excluded.

Hips were radiographed in AP projection. If the K/L grade in one or both joints was Grade 2 or higher, the individual was considered to have radiographic hip OA. Hips with arthroplasty were excluded (number of individuals = six), because the major causes of operation were osteonecrosis of the femoral head and hip fracture as well as hip OA [4, 14, 21, 33]. Individuals who missed the radiographs were also excluded (number of individuals = four). Thus, 10 individuals were excluded from the analysis.

Radiographic knee OA was determined using the three plain radiographs: weightbearing AP view, 45° flexion posteroanterior view, and the Merchant view. Knees were divided into three compartments, namely, the medial, lateral, and patellofemoral compartments on radiographs, and each compartment was graded according to the K/L scale. An individual was classified as having radiographic knee OA if their K/L grade of the worst compartment was found to be Grade 2 or higher. A total of 15 individuals received TKA. They were included in the radiographic OA group unlike hip arthroplasty, considering that knee OA was found to be the underlying cause for the majority of arthroplasty cases, according to the national registry data of TKA in Korea [20].

Intraobserver and interobserver reliabilities of the radiographic K/L grade were tested using kappa coefficients. Two orthopaedic surgeons (HJC, TKK) performed measurements twice with an interval of 3 weeks in 50 randomly selected participants. The kappa coefficients for intra- and interobserver reliabilities ranged from 0.801 to 0.902, which allowed us to rely on the validity of the radiographic assessments produced by a single investigator (HJC).

The prevalence of radiographic OA for each joint was calculated for the whole population and compared between sexes using the chi square test. To identify risk factors, associations of sex, aging, and obesity with the presence of radiographic OA were determined for each joint using the multivariate logistic regression. The odds ratio (OR) and the 95% confidence interval (CI) were calculated for sex, aging in 5-year increments, and obesity. Obesity was defined as a BMI of 25 $kg/m^2$ or greater as proposed by the Western Pacific Regional Office of the World Health Organization [2]. Statistical analyses were conducted using the SPSS for Windows statistical package (Version 12.0; SPSS, Chicago, IL, USA), and p values of $< 0.05$ were considered significant.

## Results

The highest prevalence of radiographic OA was observed in the spine (number of subjects with OA/number of whole population = 462 of 696 [66%]) followed by the hand (415 of 692 [60%]), knee (265 of 696 [38%]), shoulder (36 of 696 [5%]), and hip (15 of 686 [2%]) (Table 1). For those with spine OA, the most frequently involved level was L3/4 (149 of 297 [50%]) in males and L2/3 (176 of 398 [44%]) in females. There was no difference in the prevalence of spine OA between female and male individuals (p = 0.184), but it tended to be higher at L3/4 and L4/5 levels in male individuals (149 of 297 [50%] versus 170 of 398 [43%]; OR, 0.7; 95% CI, 0.5–1.0, p = 0.051; and 130 of 296 [44%] versus 145 of 392 [37%]; OR, 0.8; 95% CI, 0.6–1.0, p = 0.066, respectively). In the individuals with hand OA, DIP was the most frequently involved joint both in female and male individuals. Females had a higher prevalence of hand OA overall (273 of 396 [69%] versus 142 of 296 [48%]; OR, 2.4; 95% CI, 1.8–3.3; p < 0.001), for DIP (206 of 396 [52%] versus 100 of 296 [34%]; OR, 2.1; 95% CI, 1.6–2.9; p < 0.001), for PIP (91 of 396 [23%] versus 23 of 296 [8%]; OR, 3.5; 95% CI, 2.2–5.8; p < 0.001), and for thumb IP (173 of 396 [44%] versus 80 of 296 [27%]; OR, 2.1; 95% CI, 1.5–2.9; p < 0.001). However, this sex discrepancy was not obvious in the MCP and first CMC joints. Conversely, OA in the first CMC joint was relatively common in males (27 of 296 [9%] versus 34 of 396 [9%]; OR, 0.9; 95% CI, 0.6–1.6; p = 0.806). The prevalence of radiographic knee OA was approximately three times higher in females than males (214 of 398 [54%] versus 51 of 298 [17%]; OR, 5.6; 95% CI, 3.9–8.1; p < 0.001). The prevalence of radiographic shoulder OA was higher in females than males (28 of 398 [7%] versus eight of 298 [3%]; OR, 2.7; 95% CI, 1.2–6.1; p = 0.010). There was no difference in the prevalence of radiographic hip OA between female and male (seven of 391 [1.8%] versus eight of 295 [3%]; OR, 0.7; 95% CI, 0.2–1.8; p = 0.414).

After controlling for relevant confounding variables, including aging, sex, and obesity, we found that females were more likely to have OA of knee (OR, 5.7; 95% CI, 3.9–8.4; p < 0.001) and hand (OR, 2.3; 95% CI, 1.6–3.1;

**Table 1.** Number and percentage of subjects with radiographic osteoarthritis (OA) at different joint sites

| Joint | Number of subjects (prevalence of OA, %) | | | OR for female* (95% CI) | Significance* (p value) |
|---|---|---|---|---|---|
| | Whole population (N = 696) | Male (N = 298) | Female (N = 398) | | |
| Spine OA | | | | | |
| L1/2 | 254 (36.5) | 118 (39.6) | 136 (34.2) | 0.8 (0.6–1.1) | 0.141 |
| L2/3 | 317 (45.5) | 141 (47.3) | 176 (44.2) | 0.9 (0.7–1.2) | 0.417 |
| L3/4† | 319 (45.9) | 149 (50.2) | 170 (42.7) | 0.7 (0.5–1.0) | 0.051 |
| L4/5‡ | 275 (40.0) | 130 (43.9) | 145 (37.0) | 0.8 (0.6–1.0) | 0.066 |
| L5/S1§ | 185 (26.7) | 72 (24.2) | 113 (28.5) | 1.3 (0.9–1.8) | 0.197 |
| Overall | 462 (66.4) | 206 (69.1) | 256 (64.3) | 0.8 (0.6–1.1) | 0.184 |
| Shoulder OA | 36 (5.2) | 8 (2.7) | 28 (7.0) | 2.7 (1.2–6.1) | 0.010 |
| Hand OA‖ | | | | | |
| DIP | 306 (44.2) | 100 (33.8) | 206 (52.0) | 2.1 (1.6–2.9) | < 0.001 |
| PIP | 114 (16.5) | 23 (7.8) | 91 (23.0) | 3.5 (2.2–5.8) | < 0.001 |
| Thumb IP | 253 (36.6) | 80 (27.0) | 173 (43.7) | 2.1 (1.5–2.9) | < 0.001 |
| MCP | 83 (12.0) | 31 (10.5) | 52 (13.1) | 1.3 (0.8–2.1) | 0.287 |
| First CMC | 61 (8.8) | 27 (9.1) | 34 (8.6) | 0.9 (0.6–1.6) | 0.806 |
| Overall | 415 (60.0) | 142 (48.0) | 273 (68.9) | 2.4 (1.8–3.3) | < 0.001 |
| Hip OA¶ | 15 (2.2) | 8 (2.7) | 7 (1.8) | 0.7 (0.2–1.8) | 0.414 |
| Knee OA | 265 (38.1) | 51 (17.1) | 214 (53.8) | 5.6 (3.9–8.1) | < 0.001 |

* Statistical significance was determined by chi square test; number of whole population (number of males/number of females) = 695 (297/398),† 688 (296/392),‡ 694 (298/396),§ 692 (296/396),‖ 686 (295/391)¶; CI = confidence interval; DIP = distal interphalangeal; PIP = proximal interphalangeal; IP = interphalanageal; MCP = metacarpophalangeal; CMC = carpometacarpal.

**Table 2.** Estimated adjusted effects (OR with 95% CI) of epidemiologic factors on the prevalence of multiple joints osteoarthritis (OA)

| Variable | Spine OA | | Shoulder OA | | Hand OA | | Hip OA | | Knee OA | |
|---|---|---|---|---|---|---|---|---|---|---|
| | OR (95% CI) | p value | OR (95% CI) | p value | OR (95% CI) | p value | OR (95% CI) | p value | OR (95% CI) | p value |
| Female gender | **0.7 (0.5–1.0)** | **0.025** | 1.9 (0.8–4.4) | 0.132 | **2.3 (1.6–3.1)** | **< 0.001** | 0.6 (0.2–2.0) | 0.442 | **5.7 (3.9–8.4)** | **< 0.001** |
| Age (per 5 years) | **1.3 (1.1–1.6)** | **0.001** | 1.1 (0.7–1.6) | 0.637 | **1.4 (1.2–1.7)** | **< 0.001** | 1.4 (0.9–2.3) | 0.185 | **1.6 (1.4–1.9)** | **< 0.001** |
| Obesity | **1.5 (1.1–2.2)** | **0.014** | 1.7 (0.8–3.8) | 0.162 | 1.3 (0.9–1.8) | 0.178 | 1.1 (0.3–3.5) | 0.877 | **3.4 (2.4–5.0)** | **< 0.001** |

Statistically significant differences are shown in bold; ORs = odds ratio; CI = confidence interval.

$p < 0.001$), and males were more likely to have spine OA (OR for being female, 0.7; 95% CI, 0.5–1.0; $p = 0.025$) (Table 2). Aging was associated with the OA of spine (OR per 5-year increments, 1.3; 95% CI, 1.1–1.6; $p = 0.001$), hand (OR per 5-year increments, 1.4; 95% CI, 1.2–1.7; $p < 0.001$), and knee (OR per 5-year increments, 1.6; 95% CI, 1.4–1.9; $p < 0.001$). Obesity was associated with the OA of spine (OR, 1.5; 95% CI, 1.1–2.2; $p = 0.014$) and knee (OR, 3.4; 95% CI, 2.4–5.0; $p < 0.001$). For shoulder and hip OA, there were no relationships with regard to sex, aging, or obesity.

## Discussion

OA is one of the most common debilitating diseases of the elderly. Epidemiological studies of patients from different geographical locations and ethnic backgrounds provide vital information concerning the cost implications of the disease and valuable clues regarding its prevention and management. However, the majority of previous studies on the prevalence of OA have been undertaken in Europe or the United States [1, 3, 5, 10–13, 18, 22, 28, 30, 34, 35]. Although a small number of population-based studies have been conducted in Asia [7, 24, 26, 27, 39, 40], most of them have been limited primarily to China and Japan and have been focused on the OA of a single joint. Thus, ethnic and geographical variation of the pattern of joint distrubution of OA was not clearly elucidated among the same Asian populations. Furthermore, little is known about the association of demographic factors such as sex, aging, and obesity with OA in various joints of Asian populations. Therefore, we conducted this study to determine the prevalence of radiographic OA in the spine, shoulder, hand, hip, and knee and to explore the associations of demographic risk factors with OA in Koreans older than age 65 years.

Several limitations should be noted when interpreting our findings. First, selection bias related to the recruitment of participants might exist. Respondents were younger than nonrespondents. Furthermore, individuals with symptoms and disability might have been more likely to volunteer to get radiographic examination and a diagnosis. These sampling errors might induce under- or overestimation of the actual prevalence of OA in Koreans. Second, we did not exclude other types of chronic arthritis such as rheumatoid arthritis or psoriatic arthritis. Initially, we considered excluding other arthritic diseases, but decided against it because exclusion of other types of arthritis could not be possible without patient interviews and a proper workup. Accordingly, the prevalence of OA reported in this study may be higher than its actual prevalence. Third, it could be argued that the population studied is not truly representative of the Asian population because epidemiologic characteristics may vary by ethnicities and geographic region. Fourth, the study design did not allow for assessment of symptoms and disability; in other words, we addressed radiographic evaluation alone with no sense of how many patients considered their radiographic OA a health problem. Fifth, we did not check for the other social environmental data of the participants such as previous workload, history of antecedent trauma, and presence of comorbidity. Therefore, we could not determine whether they are of importance to the development of OA. Finally, one might be concerned over potential radiation hazards because the study participants undertook seven radiographs to evaluate the multiple joints. However, we could assure that radiation hazard was negligible because the sum effective radiation dose (< 2.3 mSV) of the seven radiographs was less than the annual natural background radiation dose (3 mSV) and far less than the radiation dose of a chest (7 mSV) or abdomen (8 mSV) CT scan [23, 36].

When contrasting this study's findings with those of population-based surveys conducted in the Western populations, the prevalence of spine and shoulder OA was relatively higher [3, 18, 34, 35], whereas the prevalence of hip and hand OA was lower [5, 11, 13, 27, 28, 30, 40] and that of knee OA was similar to or slightly higher than that of the Western populations (Table 3) [5, 10, 22, 28]. In comparison with studies on other Asian populations, the prevalence of hip, knee, shoulder, and hand OA was similar [7, 15, 26, 27, 39, 40], whereas the prevalence of spine OA was slightly lower than the reported prevalence [24]. However, it is difficult to directly compare ethnic and geographic variations in OA prevalence because of the different definitions of OA used and different characteristics of study populations such as the age criteria.

Despite these methodological difficulties, several unique features of the Koreans become apparent through our study. First, the prevalence of hip OA was much lower than that in the Western populations [5, 13, 27, 28, 30]. This corresponds to the reported prevalence in other Asian population studies [15, 27]. Several theories can be considered to explain the lower prevalence of hip OA in Asian populations. Classically, insufficient acetabular coverage has been postulated as a cause of hip OA in Western population [25]; thus, a lower rate of acetabular dysplasia in Asians has been suggested as a conspicuous factor for this racial difference. However, recent studies have found that shallow acetabula are actually more common in Asians than in Western populations [15, 38]. Therefore, anatomical geometry of the acetabulum is unlikely to account for the large difference in the observed prevalence. Instead, it might be partially attributable to other factors such as different lifestyles, the relatively thin Asian physique, and undetectable genetic factors. The second unique feature of the Koreans was that the prevalence of OA in the MCP and first CMC joints was lower than that in the Western and other Asian populations [40]. In this study, the prevalence of OA of MCP and first CMC joints were 12% and 9%, respectively, which are lower than those found in studies conducted in the United States and China [40]. The reasons for these ethnic variations are not clearly elucidated as yet. Given the high heritability of hand OA [6, 32], one possible explanation for the lower prevalence among Koreans is a lower prevalence of disease-susceptibility genes. However, this hypothesis does not fully explain the phenomenon. Moreover, some studies have shown that OA in the MCP and first CMC joint is related to the patient's workload or grip strength [8, 37], so these ethnic differences may not only be attributable to genetic factors, but also environmental and social factors.

Comparing the prevalence of OA according to sex, females showed a higher prevalence of OA than males in the knee, shoulder, and hand. In particular, this sex discrepancy was most distinctive in the knee, which was found to be three times more common in females (17% versus 54%). Although a higher prevalence of knee OA in females has been reported in the literature, most of the previous studies do not reveal such a remarkable sex difference (Table 3) [5, 7, 10, 22, 28, 39]. However, the present study does not provide adequate clues for the cause of this difference. We believe that this female predilection is probably the result of factors not considered in the present study such as genetic factors and different lifestyle demands. However, the association between such factors and the sex discrepancy of knee OA in Koreans remains to be determined.

On the other hand, we also found a higher prevalence of hand OA in females compared with males, and this sex discrepancy is a universal finding [11, 40]. However, when detailed comparisons were made according to pattern of joint involvement and sex, these sex disparities showed

**Table 3.** Summary of previous studies on the prevalence of osteoarthritis (OA) in spines, knees, hips, shoulders, and hands

| Joints | Study | Country | Age (years) | No. of subjects (male/female) | OA definition | Radiographic OA (%) | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Overall | Male | Female |
| Spine | Muraki et al. [24] | Japan | ≥ 60 | 2288 (818/1470) | KL grade ≥ 2 | 75.8 | 84.1 | 70.7 |
| | Kellgren and Lawrence [18] | UK | 55–64 | 358 (165/193) | KL grade ≥ 2 | 54.5 | 66.1 | 44.6 |
| | Bremmer et al. [3] | Jamaica | 35–64 | 501 (246/255) | KL grade ≥ 2 | 60.3 | 64.6 | 56.1 |
| | van Saase et al. [34] | Netherlands | ≥ 45 | 2863 (1323/1540) | KL grade ≥ 2 | 56.6 | 53.9 | 58.9 |
| | Current study | Korea | ≥ 65 | 696 (298/398) | KL grade ≥ 2 | 66.4 | 69.1 | 64.3 |
| Shoulder | Nakagawa et al. [26] | Japan | 1–88 | 345 (153/192) | Specific radiographic findings† | 4.6 | 1.3 | 7.3 |
| | van Schaardenburg et al. [35] | Netherlands | ≥ 85 | 105 (32/73) | Physical examination‡ | 3.8 | 3.1 | 4.1 |
| | Current study | Korea | ≥ 65 | 696 (298/398) | KL grade ≥ 2 | 5.2 | 2.7 | 7.0 |
| Hand | Zhang et al. [40] | China | ≥ 60 | 2507 (1004/1503) | KL grade ≥ 2 | 46.0 | 44.5 | 47.0 |
| | Zhang et al. [40] | USA | ≥ 60 | 1628 (650/978) | KL grade ≥ 2 | 81.1 | 75.2 | 85.0 |
| | Haara et al. [11] | Finland | ≥ 30 | 3595 (1560/2035) | KL grade ≥ 2 | 44.8 | 44.3 | 48.1 |
| | Current study | Korea | ≥ 65 | 696 (298/398) | KL grade ≥ 2 | 60.0 | 48.1 | 68.9 |
| Hip | Nevitt et al. [27] | China | ≥ 60 | 1492 (614/878) | JSW ≤ 1.5§ | 1.0 | 1.1 | 0.9 |
| | Nevitt et al. [27] | USA | 60–74 | 314 (156/158) | JSW ≤ 1.5§ | 4.1 | 4.5 | 3.8 |
| | Quintana et al. [30] | Spain | ≥ 60 | 7577 (3313/4264) | Questionnaire | 7.4 | 6.7 | 8.0 |
| | Cvijetic et al. [5] | Croatia | ≥ 45 | 610 (304/306) | KL grade ≥ 2 | 23.0 | 27.3 | 18.6 |
| | Hirsch et al. [13] | USA* | ≥ 45 | 749 (292/457) | KL grade ≥ 2 | 3.6 | 4.8 | 2.8 |
| | Odding et al. [28] | Netherlands | ≥ 55 | 2895 (1156/1739) | KL grade ≥ 2 | 15.2 | 14.1 | 15.9 |
| | Inoue et al. [15] | Japan | 20–70 | 782 (414/368) | KL grade ≥ 3 | 2.4 | 1.4 | 3.5 |
| | Current study | Korea | ≥ 65 | 696 (298/398) | KL grade ≥ 2 | 2.2 | 2.7 | 1.8 |
| Knee | Lethbridge-Cejku et al. [22] | USA | ≥ 20 | 898 (547/351) | KL grade ≥ 2 | 30.4 | 31.6 | 28.5 |
| | Du et al. [7] | China | ≥ 40 | 2093 (894/1199) | KL grade ≥ 2 | 44.6 | 40.6 | 47.1 |
| | Cvijetic et al. [5] | Croatia | ≥ 45 | 610 (304/306) | KL grade ≥ 2 | 7.0 | 4.3 | 9.8 |
| | Odding et al. [28] | Netherland | ≥ 55 | 2895 (1156/1739) | KL grade ≥ 2 | 24.0 | 16.3 | 29.1 |
| | Zhang et al. [39] | China | ≥ 60 | 1781 (730/1051) | KL grade ≥ 2 | 34.1 | 21.5 | 42.8 |
| | Felson et al. [10] | USA | ≥ 63 | 1420 (589/831) | KL grade ≥ 2 | 33.0 | 30.9 | 34.4 |
| | Current study | Korea | ≥ 65 | 696 (298/398) | KL grade ≥ 2 | 38.1 | 17.1 | 53.8 |

* Subjects in this study were Pima Indian residing in the United States; †shoulder OA was classified as early, advanced, and end-stage OA using the specific radiographic findings such as bony spur, sclerosis, and the distance between the humeral head and the acromion; †shoulder OA was diagnosed if there was bony crepitus in the joint in the absence of synovitis; ‡hip OA was defined using the specific radiographic features of OA including minimum joint space width (JSW) of < 1.5 mm; KL = Kellgren-Lawrence.

more diverse changes. In the DIP, PIP, and thumb IP joints, females showed a significantly higher prevalence than in males. However, this female predominance was not obvious in the MCP and first CMC joints; instead, OA in the first CMC joint was found to be more common in males. In other population-based studies, female predominance in the prevalence of OA in the DIP and PIP joints was consistent regardless of geographic area studied [11, 40]. However, sex difference in the prevalence of OA in the MCP and first CMC joints showed mixed results among various ethnic groups. In the Chinese population, males showed a higher prevalence of OA than females both in the MCP and first CMC joints [40]. On the contrary, in the Western population, males had a higher prevalence of OA in the MCP joint and lower prevalence in the first CMC joint than females [40]. With regard to the MCP and first CMC joints, sex itself may not be contributing to the development of OA, but other social and environmental factors are thought to be the culprits.

Our study was a cross-sectional survey; thus, we could not certainly establish the causality between the demographic factors and development of OA in the multiple joints. We could only identify the association between them. Obesity was closely associated with the prevalence of spine OA in our study; however, it is difficult to point to obesity as a factor in the development of OA as a result of the methodological limitation. In other population-based studies, some authors suggested that obesity was not associated with spine OA at all [12]. Furthermore, some argue that obesity is a consequence of spine OA resulting from pain and immobility rather than its cause. Therefore, the role of obesity in spine OA has not been clearly understood. Prevalence of hip and shoulder OA was not found to be associated with demographic factors. However, this study may be underpowered to assess the association for hip and shoulder OA, because the number of individuals with OA is relatively small. Therefore, we could not exactly verify the relationship between them. Previous studies have also reported contradictory results about the risk factors of hip and shoulder OA. Some studies reported a higher prevalence of hip OA in females, and they proposed female sex as one of the risk factors for hip OA [1, 9, 30, 31], whereas other studies reported the opposite results [5, 13, 27]. In the case of shoulder OA, only few previous studies suggested that presence of rotator cuff tear and a history of previous strenuous activity were highly associated with the development of shoulder OA [19, 29]. In the present study, we did not check for the aforementioned risk factors; therefore, we could not determine whether they are of importance to the development of shoulder OA. Additional observational and experimental studies with larger samples would be required for more accurate assessment of risk factors in hip and shoulder OA.

This study documents that in Koreans older than age 65 years, OA prevalence is highest in the spine followed by the hand, knee, shoulder, and hip. It means that OA of the spine, hand, and knee is likely to become a major public health problem rather than shoulder and hip OA in the rapidly growing aging society of Korea. Therefore, it should be considered in formulating national health policies to better target the management of OA. Other main findings of our results were that associations of demographic factors with OA prevalence differ with a specific joint. However, as a result of the methodological limitation, we could not establish the causality between the demographic factors and development of OA in multiple joints. Furthermore, the degree to which these findings were symptomatic was not studied here. To assess the causality between the demographic factors and OA, and the symptomatic correlation with the radiographic OA, additional well-designed observational studies with larger samples will be needed. Finally, we believe that comparing our results with the other population-based surveys may provide clues to important pathogenetic factors in OA that have likely not yet been fully recognized.

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