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Association between obesity and osteoarthritis in the South Korean older population

A nationwide population-based study

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Abstract

There are few studies on the association between obesity and radiologically-confirmed osteoarthritis (OA) in the South Korean older population. We investigated the association between obesity and radiologically-confirmed OA in a nationally-representative sample of the South Korean older population. The study population comprised 5811 participants (2530 men and 3281 women) aged ≥60 years selected from the 2010 to 2012 Korea National Health and Nutrition Examination Survey. Radiographic OA was defined as Kellgren–Lawrence grade ≥ 2 on either the knee or hip area in radiographic images. The odds ratios and 95% confidence intervals for OA were determined using multiple logistic regression analyses after adjusting for confounding factors. Overall, 7.9% and 29.6% of older men and women had OA, respectively. A U-shaped curve with the nadir in the appropriate body weight (body mass index 18.5–23 kg/m^2) revealed that 9.0%, 6.8%, 8.1%, and 9.1% of older men and 24.5%, 21.6%, 27.1%, and 38.4% of older women who were underweight, normal weight, overweight, and obese, respectively, had OA. Compared with normal-weight people, the odds ratios (95% confidence intervals) for OA in obese subjects were 1.73 (1.13–2.64) and 2.76 (2.13–3.56) for older men and women, respectively, after adjusting for age, comorbidities, lifestyle behaviors, and socioeconomic status. Obesity was significantly associated with an increased risk of OA in the South Korean older population. This finding suggests that efforts to maintain appropriate body weight and reduce excessive body weight should be considered to reduce the risk of OA in older adults.

Abbreviations: BMI = body mass index, CI = confidence interval, KL = Kellgren–Lawrence, KNHANES = Korea National Health and Nutrition Examination Survey, OA = osteoarthritis, OR = odds ratio.

Keywords: body mass index, obesity, osteoarthritis

1. Introduction

Osteoarthritis (OA) is a chronic degenerative joint disorder characterized by subchondral bone sclerosis, gradual loss of articular cartilage, and osteophyte formation (bone spurs), leading to swelling, pain, and dysfunction of the joint.[1] It is estimated that OA affects 250 million people globally, and is one of the leading causes of disability worldwide.[2] OA is related to increased health care utilization and expenses, and low quality of life in older people.[3,4] OA-related expenses are associated with considerable economic costs estimated at 1 to 2.5% of the gross domestic product in westernized countries.[5,6]

OA is known to develop because of an interaction between genetic and environmental risk factors. Genetic factors are reported to account for 39 to 65% of OA.[7] Other important risk factors include female sex, older age, and obesity.[8] Because modifiable risk factors such as obesity can be managed, controlling them appropriately can contribute to managing OA.

Much epidemiological research has focused on the association between body mass index (BMI) and the prevalence of OA within particular population groups. However, findings regarding odds ratios (ORs) for the association of obesity with OA have not been consistent, partly owing to the differences in ethnicity/race of the subjects in each study.[9] Although ethnicity/race could represent a significant risk factor for OA,[10,11] there is a lack of research on the association between obesity and radiologically-confirmed OA in the South Korean older population. Therefore, we investigated the association between obesity and radiologically-confirmed OA, in a nationally-representative sample of the South Korean older population.

2. Methods

2.1. Study population and survey overview

The current study utilized data acquired from the 2010 to 2012 Korea National Health and Nutrition Examination Survey

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The datasets generated during and/or analyzed during the current study are publicly available

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Table 1

Characteristics of study participants according to the radiologically-confirmed osteoarthritis status and sex.

	Men			Women		
	Radiologically-confirmed osteoarthritis			Radiologically-confirmed osteoarthritis		
	Presence	Absence	*P* value	Presence	Absence	*P* value
Unweighted N	204	2326		926	2355	
Age (yr)	68.7 (0.2)	70.8 (0.5)	<.001	72.3 (0.3)	69.4 (0.2)	<.001
Hypertension (%)	43.9 (4.2)	44.4 (1.2)	.908	60.9 (2.0)	52.3 (1.4)	<.001
Diabetes mellitus (%)	15.8 (2.8)	19.1 (0.9)	.295	20.9 (1.8)	16.2 (0.9)	.013
Stroke (%)	9.1 (2.2)	5.9 (0.6)	.099	4.3 (0.8)	3.9 (0.6)	.749
Current smoker (%)	30.7 (3.9)	28.1 (1.1)	.504	3.9 (0.8)	3.5 (0.5)	.662
Regular exerciser (%)	19.9 (3.3)	18.7 (1.0)	.723	13.7 (1.6)	11.3 (0.9)	.111
Regular drinker (%)	41.7 (4.1)	37.1 (1.2)	.254	4.6 (0.8)	4.7 (0.6)	.987
Residence in rural area (%)	44.4 (4.8)	29.4 (2.4)	<.001	38.4 (3.2)	30.3 (2.5)	<.001
Household income (U.S. $/month)	2332 (159)	1537 (147)	<.001	2039 (136)	1576 (169)	.033
Education level (%)			<.001			<.001
≤Elementary school	58.8 (4.2)	42.2 (1.5)		88.4 (1.3)	76.1 (1.1)	
Middle school	24.0 (3.5)	18.8 (1.2)		7.7 (1.1)	10.9 (0.7)	
High school	13.8 (3.0)	25.4 (1.1)		3.4 (0.7)	10.0 (0.8)	
≥University	3.4 (1.1)	13.6 (1.1)		0.5 (0.2)	3.0 (0.4)	

Data were reported as means (standard errors) or percentages (standard errors).

P values were determined with weighted 1-way ANOVA for continuous variables or weighted chi-squared test for categorical variables.

1 US $ was calculated as 1200 Korean won.

(KNHANES), which is performed by the Korea Centers for Disease Control and Prevention. KNHANES is a nationwide, representative, population-based survey conducted to assess the health and nutritional status of South Koreans.

In total, 25,534 participants were included in the 2010 to 2012 KNHANES, of whom 6455 were older participants aged ≥60 years. Of these, we excluded those with missing data on BMI (n = 278) and radiographic images of the hip and knee (n = 366). Thus, the final analysis included 5811 participants.

Written informed consent was obtained from all participants. The KNHANES was approved by the Institutional Review Board of the Korea Centers for Disease Control and Prevention (2012-01EXP-01-2C, 2011-02CON-06-C, and 2010-02CON-21-C). Additionally, this study complied with the ethical principles of the Declaration of Helsinki.

2.2. Definitions of terms

Trained medical staff conducted anthropometric measurements in accordance with a standardized procedure. BMI was calculated as weight (kg) divided by the square of height (m^2).

According to the Asia-Pacific regional World Health Organization and International Obesity Task Force guidelines,[12] the individuals were categorized as underweight (BMI < 18.5 kg/m^2), normal weight (18.5 kg/m^2 ≤ BMI < 23.0 kg/m^2), overweight (23.0 kg/m^2 ≤ BMI < 25.0 kg/m^2), and obese (BMI ≥ 25.0 kg/m^2).

Radiographic examinations of the hip and knee were conducted by utilizing a Synchro Stand (SD 3000) (Accele Ray, Shinyoung Co. Ltd., Seoul, Korea). Two specialized musculoskeletal radiologists graded each radiographic digital image from 0 to 4 points with the Kellgren–Lawrence (KL) grading system.[13,14] Lateral plain, bilateral anteroposterior, and weight-bearing anteroposterior radiographs were taken to assess the knees. Anteroposterior and bilateral plain radiographs were acquired to investigate the hip. The degree of radiographic OA was evaluated according to the following KL grading system: Grade 0, none: no visible features of OA; Grade 1, doubtful: questionable joint space narrowing or questionable osteophytes; Grade 2, minimal: minimal/mild joint space narrowing, definitive small osteophytes; Grade 3, moderate: joint space narrowing of at least 50%, definitive moderate osteophytes; and Grade 4, severe: severely impaired joint space, sclerosis, and subchondral bone cysts. In this research, radiographic OA was defined as KL grade ≥ 2 on either the hip or knee area in radiographic images. Each participant also informed whether they had experienced joint pain in the knees and hip for 30 or more days in the past 3 months. Individuals who met the following 2 criteria were defined as having OA: KL grade ≥ 2 on either the hip or knee area in radiographic images and knee and hip pain lasting for ≥30 days in the past 3 months.

2.3. Statistical analyses

Sampling weights were utilized to account for the complex survey design of the KNHANES. Accordingly, we attained valid estimates that were representative of the overall South Korean older population to avoid biased estimates. Characteristics of the study participants were compared using a weighted chi-square test for categorical variables and a weighted 1-way analysis of variance for continuous variables. The ORs and 95% confidence intervals (CIs) for OA were calculated using multiple logistic regression analyses after adjusting for confounding factors. All statistical analyses were performed with IBM SPSS Statistics for Windows, version 25.0 (IBM corp., Armonk, NY). Statistical significance was set at a *P* value of <.05.

3. Results

The characteristics of the 5811 participants are presented in Table 1. Of these, 2530 and 3281 were older men and women, respectively, of whom, 204 and 926 had OA, respectively. Higher proportions of rural dwellers and low-educated people had OA, in both men and women than their counterparts.

Figure 1 illustrates the prevalence of radiographically-confirmed OA according to categories of BMI (underweight, normal weight, overweight, and obesity). OA was noted in 7.9% and 29.6% of older men and women, respectively. A U-shaped curve with the nadir in the appropriate body weight (BMI 18.5–23 kg/m^2) revealed that 9.0%, 6.8%, 8.1%, and 9.1% of older men and 24.5%, 21.6%, 27.1%, and 38.4% of older women who were underweight, normal weight, overweight, and obese, respectively, had OA.

Table 2 presents the results of multiple regression analyses of the association between body weight and OA. Compared with

normal-weight people, the ORs (95% CIs) for OA in obese people were 1.73 (1.13–2.64) and 2.76 (2.13–3.56) for older men and women, respectively, after adjusting for age, comorbidities (hypertension, diabetes mellitus, coronary artery disease, and stroke), lifestyle behaviors (smoking, exercise, and drinking), and socioeconomic status (residential area, household income, and education level).

4. Discussion

In this nationally-representative cross-sectional study, we found that obesity was significantly associated with a higher risk of OA in the South Korean older population after adjusting for potential confounding factors. Although previous studies have shown the association between obesity and OA in various population groups, this research contributes to our understanding of body weight in relation to OA in the older population. In the South Korean population, Park et al reported that obesity is associated with OA in older South Korean women.[15] However, in the study by Park et al, a self-reported history of the disease was used for diagnosing OA (not radiologically confirmed), and the participants in the study were women alone. Thus, the study did not estimate OA prevalence in the entire South Korean older population. Our findings agree with the results of previous studies, showing that obesity is related to OA in various populations,[16,17] and revealing that this association also exists in the South Korean population. Moreover, our results show the prevalence of radiologically-confirmed knee and hip OA in the South Korean older population (7.9% and 29.6% of older men and women, respectively). To the best of our knowledge, this is the first large population-based research investigating the association between BMI and radiologically-confirmed OA as well as the prevalence of radiologically-confirmed knee and hip OA in the South Korean older population.

The findings regarding ORs for the association of BMI and obesity with OA have varied because of differences in the ethnicity/race of the subjects in each study. In a study of subjects in the UK by Holliday et al, compared to individuals with normal weight, subjects with overweight and obesity exhibited ORs of 2.33 and 7.48, respectively, for knee OA and 1.15 and 2.54, respectively, for hip OA.[18] Toivanen et al studied 823 Finnish subjects, and compared to subjects with normal weight, those with overweight and obesity showed ORs of 1.7 and 7.0, respectively.[19] Grotle et al evaluated 1675 Norwegian subjects and found that compared to subjects with normal weight, those

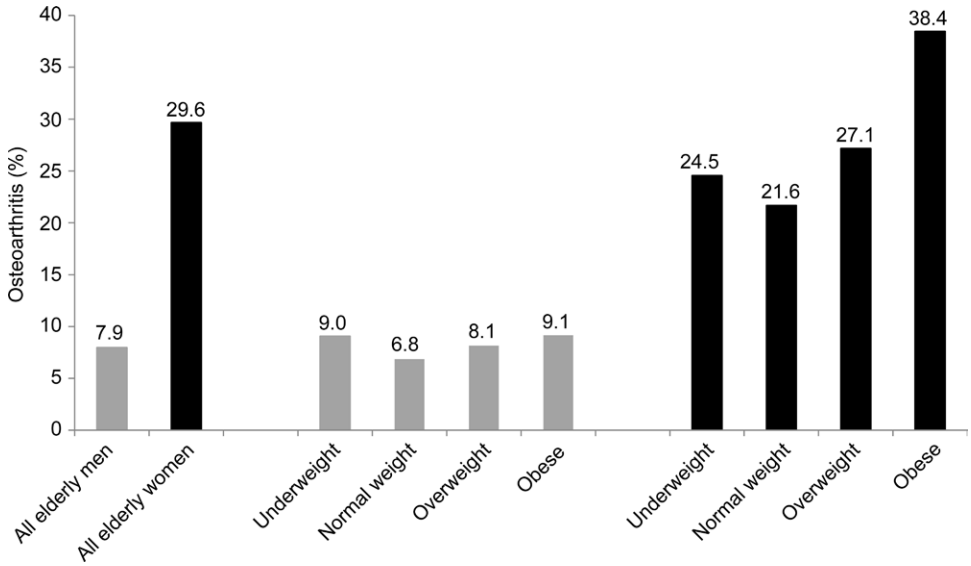

Figure 1. Prevalence of osteoarthritis according to categories of body mass index.

Table 2

Odds ratios and 95% confidence intervals for osteoarthritis according to categories of body mass index and sex.

	Men				Women			
	Underweight (BMI < 18.5 kg/m²)	Normal weight (BMI 18.5–23 kg/m²)	Overweight (BMI 23–25 kg/m²)	Obese (BMI > 25 kg/m²)	Underweight (BMI < 18.5 kg/m²)	Normal weight (BMI 18.5–23 kg/m²)	Overweight (BMI 23–25 kg/m²)	Obese (BMI > 25 kg/m²)
Model 1	1.24 (0.51–2.99)	1 (reference)	1.30 (0.85–1.99)	1.56 (1.05–2.32)	0.81 (0.40–1.64)	1 (reference)	1.50 (1.15–1.97)	2.69 (2.10–3.44)
Model 2	1.20 (0.49–2.92)	1 (reference)	1.30 (0.84–2.00)	1.61 (1.06–2.44)	0.81 (0.41–1.64)	1 (reference)	1.51 (1.16–1.98)	2.67 (2.08–3.41)
Model 3	1.15 (0.48–2.80)	1 (reference)	1.31 (0.84–2.04)	1.64 (1.08–2.47)	0.86 (0.43–1.73)	1 (reference)	1.58 (1.20–2.06)	2.72 (2.13–3.49)
Model 4	1.06 (0.43–2.62)	1 (reference)	1.41 (0.91–2.20)	1.73 (1.13–2.64)	0.85 (0.42–1.73)	1 (reference)	1.60 (1.21–2.12)	2.76 (2.13–3.56)

Model 1: adjusted for age. Model 2: adjusted for age, hypertension, diabetes mellitus, and stroke. Model 3: adjusted for age, hypertension, diabetes mellitus, stroke, smoking, exercise, and drinking. Model 4: adjusted for age, hypertension, diabetes mellitus, stroke, smoking, exercise, residential area, household income, and education level.
BMI = body mass index.

with obesity showed ORs of 2.81 for knee OA and 2.59 for hip OA.[20] A meta-analysis observed ORs of 2.02 and 3.91 (95% CI, 3.32–4.56) for overweight and obese individuals, respectively.[16] However, most of these studies were conducted in Western countries with a high prevalence of obesity, and evidence for Asian populations remains insufficient. Therefore, it is necessary to study the effects of BMI on OA in Asian populations; in particular, the Korean population tends to have a relatively low BMI.[21] Thus, the findings of the present study expand on earlier findings regarding the association between BMI and OA.

South Korea is rapidly becoming a super-aged society, and OA is highly prevalent in the older population; thus, a study investigating the OA prevalence and the relationship between obesity and OA in the older population was necessary. As previously mentioned, OA is one of the major causes of disability and the most common joint disease in the older population, and is accompanied by decreased quality of life, comorbid conditions, and increased mortality[2,4,22,23]; therefore, the prevention and management of OA are important. Our findings support the continuation of efforts to maintain appropriate body weight and reduce excessive body weight, thereby reducing the risk of OA in older adults.

OA is known to be associated with some comorbidities (such as hypertension, diabetes mellitus, coronary artery disease, and stroke),[24–27] lifestyle behaviors (smoking, exercise, and alcohol),[28–30] and socioeconomic status (residential area, household income, and education level).[31] We included these variables in multiple regression analyses to adjust for potential confounding.

This study had some limitations. The cross-sectional design makes it difficult to secure a causal association between obesity and OA in older adults. In addition, the study participants were restricted to the South Korean older population; thus, the findings may have limited generalizability to other ethnic groups. Despite these potential limitations, to our best knowledge, this is the first population-based study to reveal the association between BMI and radiologically-confirmed OA as well as the prevalence of radiologically-confirmed knee and hip OA in the South Korean older population. Moreover, we used a nationally-representative sample of the older population in South Korea, which reinforces the general applicability of the present findings. The large sample size for both sexes supports the validity of the findings.

In conclusion, obesity was significantly associated with an increased risk of OA in the South Korean older population. This finding suggests that efforts to maintain appropriate body weight and to reduce excessive body weight should be considered for reducing the risk of OA in older adults.

Author contributions

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Validation: Jae-Min Park.
Visualization: Jae-Min Park.
Writing – original draft: Jae-Min Park.
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