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Association between sitting time and orthopedic conditions in Korean older adults

Sang-Dol Kim, RN, PhD

Department of Nursing, College of Health Science, Kangwon National University, 346 Hwangio-gil, Dogye-eup, Samcheok-si, Gangwon-do 25949, Republic of Korea



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ABSTRACT

This study aimed to identify the association between sitting time and orthopedic conditions in Korean older adults. Data from adults aged ≥ 65 years from the 6th Korea National Health and Nutrition Examination Survey (2014–2015) were used for analysis ($n = 3,011$). Sitting time ≥ 7.5 h/day was significantly associated with knee joint (OR = 1.41, 95% CI: 1.11, 1.79), hip joint (OR = 1.54, 95% CI: 1.17, 2.03), and low back pain (OR = 1.44, 95% CI: 1.19, 1.74) when adjusted for sex, age, obesity, housing type, family income, education, and marital status in multiple logistic regression analyses. These findings imply that appropriate pain management according to sociodemographic characteristics in orthopedic conditions are necessary to reduce excessive sitting time in Korean older adults.

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Introduction

One of the most distinctive features of humans is upright walking. As living standards have improved, sitting time has also become gradually longer.¹ Sitting time refers to the amount of time spent doing “awake activities with a low energy expenditure (≤ 1.5 metabolic equivalent of task) in a sitting posture.”² Sitting time is an important modifiable determinant,³ a crucial risk factor,⁴ and an independent predictor of adverse health outcomes in older adults.⁵ According to previous research, older adults remain in a sitting position for a longer time than the younger population.⁶ However, the cause for this is unclear. In fact, it has not even been confirmed whether older people spend excessive time sitting due to illness or rest. After retiring from work, older adults tend to consistently spend prolonged time sitting.¹ In Korean culture, family members are educated to honor their parents from a young age. For example, when parents become older, family members ask them to rest quietly and free them from work or family affairs as a way to honor them.⁷ In the United States, the amount of time adults aged over 60 years spend in sitting behavior is about 60% of their waking time.⁸ In older Canadians, 93.6% engage in sitting behavior for ≥ 8 h/day.⁹ These examples of excessive sitting time could also apply to Korean elderly persons. Excessive sitting time has been found to lead to health problems, such as chronic cardiometabolic conditions^{10–12} and an elevated hazard ratio of cardiovascular incidence,^{11,13} increased cancer incidence¹³ and mortality,^{11,13} and all-cause mortality.^{10–12,14} It is necessary to prevent these conditions in older adults.

As mentioned above, most previous studies have focused on health problems due to excessive sitting time in older adults. On the other hand, few studies have been carried out to clarify the cause of excessive sitting time in this population. A prior systematic review stated that the association of too much sedentary behaviors with hip fracture and other orthopedic diseases was high and that low levels of physical activity were related to orthopedic injury.¹⁵ Another study indicated that sitting time was reduced by pain relief interventions in subjects with chronic low back pain.¹⁶ Besides, one study indicated that pain rather than self-reported sitting time explained the variation in the activity limitation of subjects with rheumatoid arthritis and stressed the need for pain management in this condition to reduce sitting time.¹⁷ Furthermore, another study claimed that the reduction or control of sitting time should focus on preventing various diseases due to too much sitting time.³ In addition to the orthopedic conditions, factors affecting prolonged sitting time are reported as older age,^{1,5,18} sex,^{1,3,5} and obesity^{1,5} etc.

Previous studies have applied the sociodemographic characteristics to investigate the influencing factors of excessive sedentary behavior in older adults.^{1,3,5,18} However, there have been very few studies on the association between sitting time and orthopedic conditions in older adults. Furthermore, a previous systematic review and meta-analysis indicated that the effects of interventions for reducing non-occupational sitting time were not statistically significant in older adults.¹⁹ This implies that the root cause of excessive sitting time needs to be explored and analyzed in older adults. In previous studies, sex, age, and obesity were reported as major covariates that influenced the prolonged sitting time in older adults.^{1,3,5,18} Based on the results of previous studies, it is presumed that the orthopedic conditions will also affect the prolonged sitting time in

E-mail address: Nu11110@kangwon.ac.kr

older adults. In addition, this study sought to investigate whether or not orthopedic conditions affect the prolonged sitting time due to sociodemographic variables such as sex, age, and obesity etc. in the elderly population aged 65 years and older. Hence, this study aimed to identify the associations between sitting time and orthopedic conditions in Korean older adults.

Design and methods

Study design

This study involved a secondary analysis of data extracted from the 6th Korea National Health and Nutrition Examination Surveys (KNHNES) from 2014 to 2015.²⁰ The 6th KNHNES were conducted by the Korea Centers for Disease Control and Prevention (KCDC).²⁰ These are statutory surveys aimed at calculating national statistics of health status, health consciousness and behavior, and food and nutrition consumption status. In particular, these statistical data are used as a goal setting and evaluation index of the National Health Promotion Plan and as basic data for establishing and evaluating health policies, such as health promotion programs.²⁰

The sampling framework of the 6th KNHNES entailed the use of population and housing census data available at the time of the most recent sample design. A two-stage stratified sampling method was used. The 6th KNHNES was composed of three main areas, namely health interviews, health examination, and nutritional survey.²⁰ The present study used data from health interviews and health examinations. The health survey excluded subjects who were hospitalized, in nursing homes or special facilities, and those who were unable to access the mobile examination cars without the help of others due to mobility problems.²⁰ The survey assessing sitting time was conducted from 2014 to 2015. Therefore, these 2-year data were stratified, clustered, and weighted to produce a complex sample plan file. Sampling weight for the complex sample plan file was allocated to every sample by integrated weighting values, such as health surveys and screenings, to ensure the representativeness of the sample.²⁰ The weights were corrected for inclusion errors, unequal extraction rates, and non-responding errors of participants who were not included in the survey.²⁰ Therefore, the analysis data increased the representativeness and accuracy of estimates of prevalence rates related to health behaviors and chronic diseases in the Korean population.

Ethical considerations

The 6th KNHNES was approved by the Institutional Review Board of the KCDC (2013-07CON-03-4C and 2013-12EXP-03-5C).²⁰ The raw data used in this study were provided by legitimate procedures through the KNHNES website under the KCDC (https://knhanes.cdc.go.kr/knhanes/sub03/sub03_01.do). In this study, personal information in the raw data was fully anonymized. The informed consent of the participants was not required for this study.

Participants

Data from adults aged ≥ 65 years from the 6th KNHNES (2014–2015) were used for the current analysis. The framework of the 6th KNHNES used a two-stage stratified cluster probability sampling method based on the first and second extraction units of the investigation areas and households to extract representative samples of Koreans who lived in Korea for ≥ 1 year ($n = 14,930$: men = 6766, women = 8164). For the purpose of the current analysis, the sample was limited to those 65 years and older ($n = 3011$: men = 1301, women = 1710) with normal cognitive function without diagnosis of dementia. Data weighting was performing according to the KNHNES user guide.²⁰

Sedentary time and physical activity assessment

Sitting time was surveyed by interview according to the KNHNES user guide.²⁰ Sitting time was defined as daily time spent “sitting or lying down at work, at home, getting to and from places, or with friends, except sleeping time.” Sitting time was assessed with the question: “The following is a question about sitting or lying down during work, with friends, at work, at home, moving to places, except sleeping time. How many hours are you usually sitting or lying down in a day?”²⁰ The response was recorded in hours. Sitting time was dichotomized into <7.5 h/day and ≥ 7.5 h/day; this cut-off time was chosen based on a meta-analysis in which it was suggested that the risk of all-cause mortality increases when self-reported sitting time was more than approximately 7–8 h/day.^{10,21}

Physical activity was also surveyed by interview according to the KNHNES user guide.²⁰ Types of physical activity were classified into work, leisure, and place movement, and the intensity level of physical activity was classified as vigorous and moderate intensity. Vigorous physical activity refers to activities in which breathing is very difficult or the heart beats very quickly. Moderate physical activity refers to activities in which breathing is slightly harder or the heart beats slightly faster.

Orthopedic assessment

Orthopedic conditions were surveyed in two ways. First, the respondent checked a box or entered numbers in response to the following questions on osteoarthritis and rheumatoid arthritis: “Were you diagnosed by a doctor, when was the time of your first diagnosis, what is your current condition, and what is your current treatment?” Second, we asked the following question: “Have you had knee joint pain (knee joint stiffness, hip joint pain, and low back pain) for more than 30 days in the last 3 months?” The possible responses were “yes,” “no,” “not applicable,” or “no response.” Of these responses, “not applicable” and “no response” were treated as missing values.²⁰

Body mass index assessment

Body mass index (BMI) was calculated by measuring height and weight using a digital stadiometer (GL-6000-20; G-tech, Seoul, Korea) and electronic scales (Seca 225; Seca, GmbH & Co, Hamburg, Germany), respectively. BMI was categorized as underweight (<18.5 kg/m²), normal weight (18.5–24.9 kg/m²), or obese (≥ 25 kg/m²) based on the KNHNES BMI criteria.¹⁶

Statistical analysis

Data analysis was conducted using SPSS version 18.0 (IBM Corp., Armonk, NY). Frequencies of sociodemographic variables were presented as percentages. Sampling weights were generated with consideration of a complex sample to ensure the representativeness of the sample relative to the Korean population. Chi-square and standardized, adjusted residual tests were used to assess statistically significant differences between men and women according to other sociodemographic variables. Multiple logistic regression analyses were used to identify associations between sedentary time and orthopedic conditions. P -values <0.05 were considered statistically significant.

Results

Participant characteristics

The characteristics of the participants of the 6th KNHNES are presented in Table 1. The mean (standard error) age of the participants was 72.93 (0.11) years. The gender ratio was 58.3% women to 41.7% men. Nearly 54.9% of the participants self-reported sitting time ≥ 7.5 h/day.

Table 1
Characteristics of the sample (South Korea, 2014–2015).

Characteristics	Combined (n = 3011)	Male (n = 1301)	Female (n = 1710)
Age category, mean (SE)	72.93 (0.11)	72.35 (0.15)	73.35 (0.15)
65–69	32.5	36.5	29.5*
70–74	28.3	27.2	29.2
75–79	23.2	23.2	23.2
80–84	15.9	13.1	18.1*
Obesity			
Yes (BMI 25 > kg/m ²)	63.6	68.5	60.1*
No (BMI 25 ≤ kg/m ²)	36.4	31.5	39.9*
Housing type			
General	65.7	65.8	65.7
Apartment	34.2	34.3	34.3
Education level			
≤Elementary school	61.4	40.7	77.4*
Middle school	13.3	18.4	9.4*
High school	16.4	25.5	9.4*
>College	8.9	15.5	3.7*
Family income level			
Lower	47.1	40.6	52.1*
Lower middle	27.1	30.2	24.8*
Middle upper	15.4	17.0	14.1*
Upper	10.4	12.1	9.0*
Marital status			
Single	0.7	0.7	0.7
Married	99.3	99.3	99.3
Sitting time, mean ± SD	7.95±3.70	8.02±3.72	7.88±3.68
Less than 7.5 h per day	45.1	51.2	40.4*
7.5 h or more than per day	54.9	48.8	59.6*
Osteoarthritis			
Yes	92.7	89.0	93.6*
No	7.3	11.0	6.4*
Rheumatoid arthritis			
Yes	83.1	69.2	85.7
No	16.9	30.8	14.3
Knee stiffness			
Yes	17.2	8.5	24.0*
No	82.8	91.5	76.0*
Knee joint pain			
Yes	27.3	15.3	36.5*
No	72.7	84.7	63.5*
Hip joint pain			
Yes	12.8	6.3	17.7*
No	87.2	93.7	82.3*
Low back pain			
Yes	30.5	18.5	39.8*
No	69.5	81.5	60.2*
Physical activity intensity levels			
Vigorous work			
Yes	0.8	0.7	0.7
No	99.2	99.3	99.3
Moderate work			
Yes	7.5	4.9	6.0
No	92.5	95.5	94.0
Vigorous leisure			
Yes	3.5	0.3	1.7*
No	96.5	99.7	98.3*
Moderate leisure			
Yes	17.3	8.1	12.0*
No	82.7	91.9	88.0*
Moving places			
Yes	55.8	58.0	57.1
No	44.2	42.0	42.9

Frequencies are presented as a percent of the sample; columns total 100%.

SE; Standard error.

* $p < 0.05$.

Sociodemographic characteristics and sitting time

The associations between sitting time and sociodemographic variables are presented Table 2. Age was significantly associated with sitting time, with younger participants reporting less sitting time. The association between obesity and sitting time was significant among men

(odds ratio [OR]: 0.68; 95% confidence interval [CI] 0.57, 0.81, $p < 0.05$) and women (OR: 1.48; 95% CI: 1.24, 1.76, $p < 0.05$). Regarding educational level, female college graduates had 63% lower odds of sitting ≥ 7.5 h/day (OR: 0.37; 95% CI: 0.19, 0.72, $p < 0.05$) than those with less than elementary school graduation. Regarding physical activity intensity levels, participants with vigorous intensity work had 85% lower odds of sitting ≥ 7.5 h/day (OR: 0.15; 95% CI: 0.44, 0.64 $p < 0.05$), those with moderate intensity work had 44% lower odds of sitting ≥ 7.5 h/day (OR: 0.56; 95% CI: 0.32, 0.97, $p < 0.05$), and those with vigorous intensity leisure had 57% lower odds of sitting ≥ 7.5 h/day (OR: 0.43; 95% CI: 0.19, 0.95, $p < 0.05$) than those who do not, respectively.

Orthopedic conditions and sedentary time

Associations between sitting time and orthopedic conditions were identified. Knee joint pain (OR: 1.41; 95% CI: 1.11–1.79, $p < 0.05$), hip joint pain (OR: 1.54; 95% CI: 1.17, 2.03, $p < 0.05$), and low back pain (OR: 1.44; 95% CI: 1.19, 1.74, $p < 0.001$) were significantly associated with sitting time ≥ 7.5 h/day when adjusting for gender, age, obesity, housing type, family income, education, and marital status (Table 3).

Table 2
Association between sitting time and sociodemographic characteristics by sex.

Characteristics	Combined		Male		Female	
	OR	95% CI	OR	95% CI	OR	95% CI
Age category						
65–69	0.24*	0.18–0.31	0.29*	0.12–0.72	0.17*	0.06–0.55
70–74	0.36*	0.27–0.49	0.41*	0.23–0.76	0.33*	0.16–0.72
75–79	0.55*	0.41–0.74	0.58*	0.40–0.84	0.59*	0.59–0.97
80–84	1	Referent	1	Referent	1	Referent
Obesity						
Yes (BMI 25 > kg/m ²)	1.09*	0.90–1.31	0.68*	0.57–0.81	1.48*	1.24–1.76
No (BMI 25 ≤ kg/m ²)	1	Referent	1	Referent	1	Referent
Housing type						
General	1	Referent	1	Referent	1	Referent
Apartment	1.13	0.92–1.40	1.14	0.92–1.41	1.13	0.86–1.49
Education level						
≤Elementary school	0.98	0.69–1.39	0.94	0.66–1.34	0.37*	0.19–0.72
Middle school	0.90	0.63–1.28	0.89	0.62–1.28	0.43*	0.20–0.92
High school	0.93	0.64–1.36	0.92	0.63–1.34	0.43*	0.20–0.91
>College	1	Referent	1	Referent	1	Referent
Family income level						
≤Lower	0.87	0.60–1.25	0.72	0.49–1.05	1.09	0.69–1.73
>Lower - ≤ middle	0.81	0.54–1.23	0.76	0.50–1.15	0.93	0.58–1.48
>Middle - ≤ upper	0.83	0.58–1.20	0.82	0.57–1.17	0.90	0.54–1.49
>Upper	1	Referent	1	Referent	1	Referent
Marital status						
Single	1	Referent	1	Referent	1	Referent
Married	0.81	0.29–2.24	0.81	0.28–2.28	0.81	0.28–2.28
Physical activity intensity levels						
Vigorous work						
Yes	0.15*	0.04–0.64	1.68	0.99–2.84	1.30	0.98–1.69
No	1	Referent	1	Referent	1	Referent
Moderate work						
Yes	0.56*	0.32–0.97	1.66	0.96–2.85	1.29	0.98–1.69
No	1	Referent	1	Referent	1	Referent
Vigorous leisure						
Yes	0.43*	0.19–0.95	1.63	0.95–2.82	1.28	0.97–1.67
No	1	Referent	1	Referent	1	Referent
Moderate leisure						
Yes	0.77	0.52–1.15	1.64	0.95–2.82	1.28	0.98–1.68
No	1	Referent	1	Referent	1	Referent
Moving places						
Yes	0.77	0.59–1.00	1.93	1.01–2.94	1.31	1.01–1.72
No	1	Referent	1	Referent	1	Referent

All association are adjusted for age; both sexes also adjusted for sex.

OR; odds ratio, CI; confidence interval, h; hour, d; day.

* $p < 0.05$.

Table 3
Association between sitting time and orthopedic conditions in Korean older adults.

Characteristics	Sex, age, and obesity adjusted			Multivariable adjusted*		
	Weighted OR	95% CI	<i>p</i> value	Weighted OR	95% CI	<i>p</i> value
Osteoarthritis						
Yes	1.55	0.77–3.13	0.217	1.72	0.86–3.43	0.126
No	1	Referent		1	Referent	
Rheumatoid arthritis						
Yes	1.53	0.50–4.68	0.445	1.43	0.33–6.13	0.701
No	1	Referent		1	Referent	
Knee stiffness						
Yes	1.18	0.94–1.51	0.157	1.25	0.97–1.61	0.084
No	1	Referent		1	Referent	
Knee joint pain						
Yes	1.36*	1.08–1.70	0.008	1.41*	1.11–1.79	0.006
No	1	Referent		1	Referent	
Hip joint pain						
Yes	1.50*	1.13–1.65	0.004	1.54*	1.17–2.03	0.002
No	1	Referent		1	Referent	
Low back pain						
Yes	1.40*	1.16–1.69	0.000	1.44*	1.19–1.74	0.000
No	1	Referent		1	Referent	

OR; odds ratio, CI; confidence interval.

* Adjusted for sex, age, obesity, housing type, family income, education, and marital status.

**p* < 0.05.

Discussion

In this study, the sociodemographic variables significantly associated with sitting time were age, obesity, and education. The association between age and sitting time supports the findings of previous studies in which older age was associated with longer sitting time.^{5,18,22} This implies that more careful observation and care are needed to reduce sitting time in older adults. Obesity was significantly associated with sitting time in both men and women. This is similar to the result of a previous study in which sedentary behavior was less likely in those with a normal weight compared to those with obesity.⁵ However, interestingly, obese men had 32% lower odds of excessive sitting, whereas obese women had 48% higher odds of sitting. These findings are consistent with those of previous studies that suggested prolonged sitting time in obese older women, but not in obese older men populations.^{23–25} According to previous studies, it was explained that the men and women have different patterns of sedentary lifestyle in older adults.^{23–25} For example, older women live longer at home than older men. In addition,^{22,23} older women tend to watch TV longer and have more chores than older men.^{24,25} Unlike previous studies, this study has no data to investigate the patterns of sedentary lifestyle of older adults. In present study, this gender difference in the relationship between obesity and sitting time implies that it is necessary to confirm whether women are more vulnerable to orthopedic conditions. In addition, these findings confirm that controlling weight is an important method of decreasing sitting time in older adults.^{5,26,27} Educational level was significantly associated with sitting time among women but not men. Female college graduates had 63% higher odds of sitting ≥ 7.5 h/day than those with less than elementary school graduation. It may be presumed that women who graduated from college mainly engaged in white-collar occupations, whereas women with less than elementary school education engaged in active occupations. Future research should assess educational differences in sedentary time in detail.

Interestingly, vigorous and moderate physical activities at work were negatively associated with sitting time in older adults. Vigorous physical activity in leisure was also negatively associated with sitting time. These findings are in agreement with the notion that excessive sitting behavior and physical inactivity have negative health effects.²⁸ On the other hand, these results differ from the finding that vigorous physical activities were not associated with physical health.²⁹ A

previous study suggested that evidence-based strategies for reducing sitting time or increasing physical activity would potentially benefit older adults.²⁸ Therefore, it is necessary to promote appropriate physical activity to reduce long sitting time in older adults.

Surprisingly, there was a significant association of knee joint pain, hip joint pain, and low back pain with sitting time when adjusting for gender, age, obesity, housing type, family income, education level, and marital status, but no association of sitting time was found with osteoarthritis, rheumatoid arthritis, and knee joint stiffness. It is likely that activity-induced pain led to the continuation of sedentary life patterns in older adults with orthopedic conditions. A previous study indicated that pain management is a target method for reducing sitting time, as pain rather than sedentary time explains the variations in activity limitation due to rheumatoid arthritis¹⁹; thus, arthritis-induced pain leads to an increased sedentary lifestyle.^{5,19,30} Moreover, another study suggested that too much sitting behavior was associated with multiple chronic diseases and the amount of medication intake in older adults.¹³ It was also suggested that inappropriate doses of medications prescribed to older adults could lead to their inactivity and sedentarism.¹³ Additionally, a study stressed that health education could be an important key for developing interventions to reduce excessive sitting time among older adults.⁵ A prior study indicated that older adults with chronic diseases do not understand the fact that excessive sedentary behavior can have negative effects on their health.⁵ Another study suggested that individually tailored, motivational counseling interventions could reduce sitting time in patients with rheumatoid arthritis.³¹ Based on the above results, older adults tend to show increased sitting behavior because of pain due to various orthopedic conditions. These findings imply that the reduction of sitting time should focus on pain control due to orthopedic conditions in this population. Furthermore, rigorous medication management is important for modifying the excessively sedentary lifestyle of older adults.

The present study has some limitations. First, the data in the 6th KNHNES were self-reported by interview. It is suggested that self-reported surveys have generally less validity and reliability than objective observations and measurements.^{5,32} There is still controversy about the accuracy of self-reported sitting time and physical activity in older adults. Therefore, future research should be performed with valid and reliable self-reported measures to obtain unbiased data. Further, the present study investigated knee joint stiffness and pain, hip joint pain,

and low back pain regardless of whether medication was taken. This likely caused bias in the assessment of sitting time, as the history of medication therapy for orthopedic conditions and other diseases may differ in older adults. This implies that the history of medication needs to be identified simultaneously when sitting time is assessed in older adults. There was no association between sitting time and osteoarthritis or rheumatoid arthritis; however, in the present study, patients with orthopedic diseases such as osteoarthritis and rheumatoid arthritis could not confirm the level of pain because they were taking prescription drugs. Thus, we could not infer whether sitting time was reduced because the conditions were alleviated by prescription medication. Therefore, in future studies on the relationship between sitting time and orthopedic conditions, it is necessary to use medication as an adjustment factor.

Conclusion

Despite the various limitations, the present study confirmed that knee joint pain, hip joint pain, and low back pain were significantly associated with sitting time when adjusting for sex, age, obesity, housing type, family income, education level, and marital status. In addition, vigorous and moderate physical activity at work and vigorous leisure activities were negatively associated with sitting time. Therefore, these findings imply that appropriate physical activities and pain control according to sociodemographic characteristics in orthopedic conditions are necessary to reduce excessive sitting time in Korean older adults.

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Supplementary materials

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