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An Empirical Study on the Effects of Walking Time on Knee Joint Pain Based on Korea National Health and Nutrition Examination Survey Data

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Objectives: It is generally reported that walking has a positive effect on knee joint pain. However, since previous studies have focused on small patient data and simple average comparisons, we proceed with more sophisticated empirical research using public data. Since the knee joint pain itself can be considered very important in terms of preventative medicine, we analyze that use of big data to identify its effect on knee joint pain. **Methods:** The present study used a logistic regression analysis and analyzed the effect of walking time on knee joint pain in the activities of daily living based on data from the 6th 2013–2014 Korea National Health and Nutrition Examination Survey. **Results:** Smoking, Drinking and Sedentary time has no statistically significance on knee joint pain. And walking (moderate, high) has been shown to reduce the risk of knee joint pain. **Conclusion:** The results confirmed that walking time had a positive effect on the prevalence of knee joint pain. However, individuals with moderate-intensity walking time and those with high-intensity walking time had different effects on preventing knee joint pain.

Keywords: Waking, Logistic Models, Knee Joint, Korea, Big Data

Introduction

The Korean population is aging at the fastest pace among member states of the Organization for Economic Co-operation and Development. The number of individuals aged 65 years or older in 2018 reached 7.315 million, and the country was already considered "super-aged" in 2017 [1]. The prevalence of chronic diseases has also increased along with the growing elderly population. The prevalence of chronic diseases among those aged 65 years and older significantly increased from 85.5% in 2008 to 2011. The number of chronic diseases also increased from 2.7 in 2008 to 4.2 in 2011. In addition, the annual number of individuals treated for arthritis also increased rapidly from 4,082,690 in 2011 to 4,491,909 in 2018 [2,3]. Among these

diseases, knee arthritis is characterized by symptoms such as pain and stiffness in the knee joint and pathological findings such as loss of knee cartilage, joint space narrowing, and osteophytes [4,5]. Of the aforementioned symptoms, knee joint pain is considered the major symptom of knee arthritis, with many patients requesting prompt treatment of this symptom and has been reported to cause problems related to declining physical function, limited activities of daily living, and disabilities [6-9].

A literature review on the previous studies showed that in terms of demographics, the prevalence of knee joint pain increased more in men than in women, in individuals aged 70 years or older, and in those with a lower educational level. In terms of health, the prevalence increased more in those with obesity and with a higher level of stress and depression [10]. When the risk factors for knee arthritis were analyzed for adults in their 50's in some regions in Korea, the likelihood of knee arthritis increased most in those not married and in those with an unstable job. Furthermore, drinking and smoking, which are lifestyle habits, did not show a statistically significant differing percentage [11].

Mean while, physical activity reduces pain and stiffness in the knee joint and maintains or increases the joint's range of motion. Furthermore, it is also known to partially restore lost motor function and maintain the joint's basic function. One of the purposes of exercise for knee arthritis patients is to improve overall functions in the body, including enhancing muscular strength or endurance. Exercise also has additional advantages such as improving psychological health, reducing stress, and increasing sleep satisfaction [12, 13]. Additionally, a light walk has been reported to be more helpful for a higher level of knee joint pain, and some argue that moderate-intensity walking would result in more strain than low-intensity walking [14]. The findings of the above studies suggest that a knee joint pain is a common musculoskeletal problem in patients with arthritis and has a negative effect on the patients' quality of life. According to the statistics published by the National Health Insurance Service, healthcare costs for gonarthrosis, which refers to knee joint pain and dysfunction due to all possible causes including primary, posttraumatic, secondary, and unspecified, have been increasing annually [15]. Not only direct healthcare costs but also indirect healthcare costs including disabilities, missed work, and lost jobs would result in a social burden beyond the personal level [16]. As described above, while it is urgent to establish a strategy to prevent knee joint pain which decreases an individual's quality of life and results in social costs, systematic studies are insufficient that analyze the prevalence and risk factors of knee joint pain at the national level

In addition, previous studies related to knee joint pain identified the effects of walking activities by classifying them as simple discrete variables and continuous variables [17, 18]. So, it was difficult to estimate the exact effect of walking and there were limitations in determining the exact size of the effects due to the lack of data. However, in this study, walking time has been broken down into three levels, This has the advantage of knowing how walking time can have specific effects. Our research has differentiated itself from previous research because detailed walking time can identify the prevalence of knee joint pain and effective walking time for each hour. These studies are believed to have a significant relationship to Mongolians who are genetically almost identical to Koreans This could also be a fundamental source for the study of knee joint pain in Mongolia [19].

The present study aimed to analyze the effect of walking time on knee jointpain in the activities of daily living. By performing a multiple logistics regression analysis based on the government-approved 6th Korea National Health and Nutrition Examination Survey (KNHANES), we aimed to provide basic references for knee joint pain prevention.

Materials and Methods

Subjects

The present study used the 6th KNHANES (2013–2014), which was conducted in Korea. The KNHANES consists of the following four parts: Health Interview Survey on disease occurrence, limited activities, injury due to accident, and healthcare use; Health Behavior Survey on drinking, smoking, and others; Health Examination Survey; and Nutrition Survey. The KNHANES was conducted pursuant to the Ethical Principles for Medical Research Involving Human Subjects under the Declaration of Helsinki. The 6th KNHANES obtained its approval from the Institutional Review Board of the Korea Centers for Disease Control and Prevention (Approval No.: 2013-12EXP-03-4C, 2014-12EXP-03-5C), and all subjects provided informed consent for inclusion in the study.

Based on the Population and Housing Census, the present

study's subjects were stratified by administrative division (dong/eup or myeon) and type of housing (apartment/detached house) in 7 regional strata (7 metropolitan cities and 6 provinces including Gyeonggi, Gangwon, Chungcheong, Jeolla, Gyeongsang, and Jeju). Subsequently, systematic sampling was used to extract sample enumeration districts in proportion to each stratum's population enumeration district. In each sample enumeration district, we selected sample households using systematic sampling and examined all members of the selected households. From this sample, we used the following data from men and women aged 50 years or older: sex, income, place of residence, age, educational level, type of occupation, marital status, private health insurance, economic activity, smoking, drinking, and walking time. The present study selected 3,181 subjects out of the 15,568 subjects in the 2013 and 2014 data after excluding those aged under 50 years, those who did not take the knee joint pain questionnaire survey, those with no surveyed walking time data, those with singular values or outliers, and those with other chronic diseases.

Variables

The outcome variable used in the present study was knee joint pain. Knee joint pain was defined to refer to the respondents who answered "Yes" to the question "Have you had knee joint pain for more than 30 days in the last 3 months?" The control variables were demographic and socioeconomic variables such as sex, income, place of residence, age, and educational level, type of occupation, marital status, private health insurance, and economic activity.

The explanatory variables, considered as inputs in the models, included smoking, drinking, sedentary time, and walking time. The smoking variable was divided into two groups: current smoker, nonsmoker, and ex-smoker. The drinking variable was categorized into two groups: 2 drinks/month to 3 drinks/week and 4 drinks/week. The sedentary time variable was divided into two groups: less than 9 hours and 9 hours or longer. The walking time variable was divided into three groups: walk rarely (1), walk moderately (2), and walk often (3). The walk rarely (1) group refers to those who walked for less than 30 minutes per day and

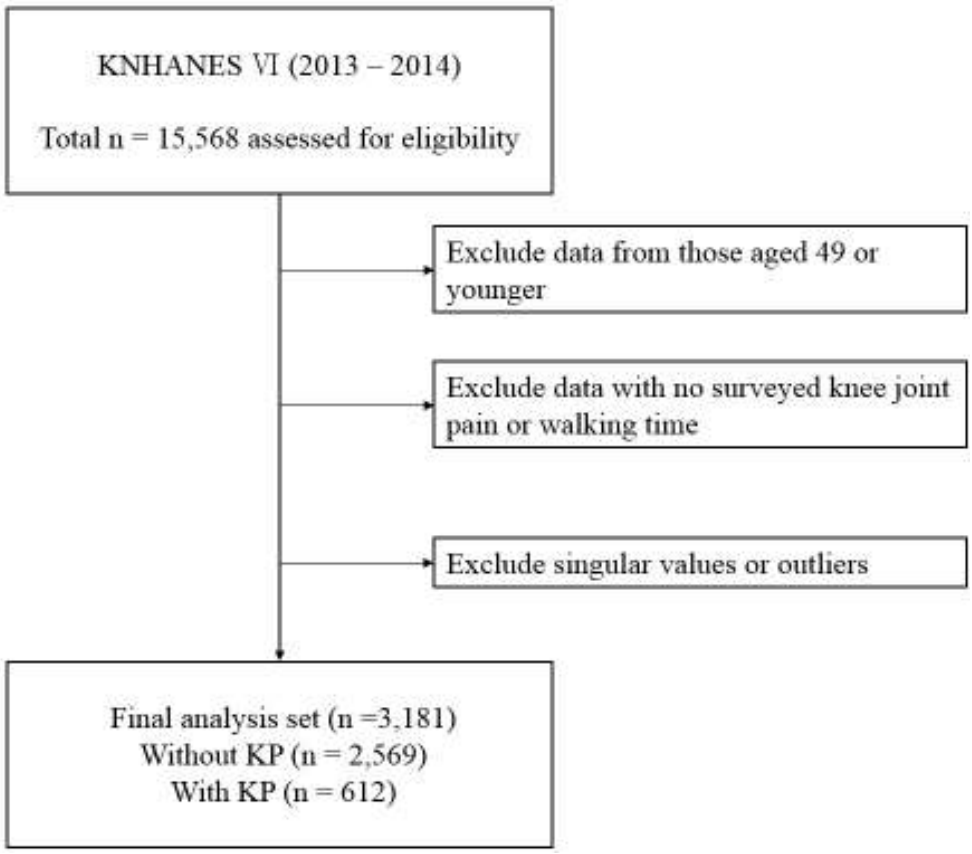

Figure 1. Flow diagram of the final sample decision process from the Korea National Health and Nutrition Examination Survey

Table 1. Characteristics of the control variable sample according to knee joint pain.

	Non-knee joint pain N %	Knee joint pain N%	χ^2	p-value
Total	2569	612		
Sex				
Women	1263 (49.2)	103 (16.8)	210.89	<.001
Men	1306 (50.8)	509 (83.2)		
Income				
Low	453 (17.6)	133 (21.7)	7.18	.126
Low-moderate	463 (18.0)	114 (18.6)		
Moderate	471 (18.3)	113 (18.5)		
Moderate-high	558 (21.7)	120 (19.6)		
High	624 (24.3)	132 (21.6)		
Place of residence				
Rural	399 (15.5)	87 (14.2)	0.66	.453
Urban	2170 (84.5)	525 (85.8)		
Age (years)				
50–59	1131 (44.0)	133 (21.7)	118.66	<.001
60–69	834 (32.5)	232 (37.9)		
Over 70	604 (23.5)	247 (40.4)		
Educational level				
≤6 years	581 (22.6)	289 (47.2)	188.33	<.001
7–9 years	465 (18.1)	130 (21.2)		
10–12 years	757 (29.5)	118 (19.3)		
≥13 years	766 (29.8)	75 (12.3)		
Type of occupation				
Unemployed	244 (9,5)	13 (2.1)	97.59	<.001
Office work	175 (6.8)	7 (1.1)		
Sales and services	312 (12.1)	63 (10.3)		
Agriculture, forestry, and fishery	689 (26.8)	145 (23.7)		
Machine fitting and simple labor	1149 (44.7)	384 (62.7)		
Marital status				
Married	2345 (91.3)	557 (91.0)	1.65	.438
Single	179 (7.0)	48 (7.8)		
Widowed	45 (1.8)	7 (1.1)		
Private health insurance				
No	742 (29.0)	247 (40.6)	31.21	<.001
Yes	1821 (71.0)	361 (59.4)		
Economic activity				
No	1149 (44.8)	384 (62.7)	63.88	<.001
Yes	1417 (55.2)	228 (37.3)		

Note: type of occupation and martial status variables are categorical variables in Table 1, but we made binary-variables of each group in the logistic regression.

less than 3 days per week. The walk moderately (2) group refers to those who walked for less than 30 minutes per day, 3 days to less than 5 days per week. The walk often (3) group refers to those who walked for 1 hour or longer per day, 5 days or more per week [20]. All variables, considered as inputs in the present study, were tested using the Mantel-Haenszel chi-squared test, which is appropriate for categorical data.

Statistical Analysis

We calculated the prevalence of knee joint pain depending on the demographic variables and conducted the Mantel-Haenszel chi-squared test to test the significance of group or categorical variables. Furthermore, we divided the prevalence of knee joint pain adjusting for all covariates in each question into no (without problem) and yes (with problem) and performed logistic regression. More specifically, multivariate logistic regression adjusting for the confounding variables was performed for the odds ratio and 95% confidence interval of the prevalence of knee joint pain in models that applied different control variables, and Stata/SE version 13.0 (Stata Statistical Software: Release 13; Stata Corp LLC, College Station, TX, USA) was used for all statistical analyses.

Ethical Statement

Ethical approval of the Nanoori hospital ethics committee was taken (NR IRB 2019-011).

Results

Demographic Characteristics

First, the following table shows the differences in demographic characteristics between the knee joint pain group and the non-knee joint pain group.

A difference in sex was first observed between the knee joint pain group and the non-knee joint pain group (=210.89, p>.001). Regarding income, a difference was also observed between the two groups (=7.18, p>.001). There was no difference in the place of residence between the two groups (=0.66, p=.453).

Regarding age, a difference was observed between the knee joint pain group and the non-knee joint pain group (=118.66, p>.001). The knee joint pain group had a higher prevalence of knee joint pain as age increased than the non-knee joint pain group.

Regarding educational level, a difference between the two groups was also observed (=188.33, p>.001). Type of occupation

Table 2. Characteristics of the explanatory variable sample according to knee pain.

Variables	Non-knee pain N %	Knee pain N %	χ^2	p-value
Smoking				
Nonsmoker and ex-smoker	1500 (58.4)	499 (81.7)	114.40	<.001
Current smoker	1068 (41.6)	112 (18.3)		
Drinking				
2 drinks/month to 3 drinks/week	2179 (84.9)	443 (72.4)	52.75	<.001
4 drinks/week	390 (15.2)	169 (27.6)		
Sedentary time				
Less than 9 hours	1600 (62.3)	382 (62.4)	34.18	<.05
9 hours or longer	969 (37.7)	230 (37.6)		
Walking time				
Walk rarely	1297 (50.5)	359 (58.7)		
Walk moderately	452 (17.6)	89 (14.5)	13.24	<.001
Walk often	820 (31.9)	164 (26.8)		

***p< .01**p<.05*p<.1

showed a difference between the two groups (=97.59, p>.001), whereas marital status showed no difference between the two groups (=1.65, p=.438).

Finally, a difference was observed between the two groups in private health insurance (=31.21, p>.001) and economic activity (=63.88, p>.001).

Life Style Habit Differences Among the Subjects

Explanatory variables, considered as inputs in the models, were analyzed for differences between the knee joint pain group and the non-knee joint pain group. Considering that the explanatory variables were also group or categorical variables, the Mantel-Haenszel chi-squared test was used for analysis. Table 2 presents the results.

For starters, smoking showed a difference between the knee joint pain group and the non-knee joint pain group (=114.40, p>.001). We also observed a significant difference in drinking between the two groups (=52.75, p>.001). Furthermore, a difference in sedentary time was observed between the two groups (=34.18, p = .017). Finally, we also observed that there was a difference in walking time between the two groups =13.24, p=.004), and all the explanatory variables were statistically significant. Next, we analyzed using the multiful logistic regression model. A total of three models were assumed. The first model was not applied all of control parameters. The second model only controlled sex and age. The last model applied all the control variables.

Model 1, which did not apply the control variables, showed that smokers were less likely to have knee joint pain than nonsmokers or ex-smokers, and those who drank more often were more likely to have knee joint pain than those who drank less. Furthermore, those who walked moderately or often were less likely to suffer from knee joint pain than those who walked rarely. However, as this model did not adjust for any control variable, the effect of explanatory variables on the outcome variable was mixed, which would result in lower reliability. Model 2, which controlled sex and age to increase data reliability, is expressed below.

Table 3. Association between walking time and knee pain using multiple logistic regression.

Variables	Unadjusted		Adjusted			
	Model 1		Model 2†		Model 3‡	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
Sex						
Women			3.09 (2.62-3.51)	<.001	1.41 (1.18-1.70)	.022
Men	1.0					
Age (years)						
50–59	1.0					
60–69			2.30 (1.97-2.64)	<.001	1.56 (1.05-1.96)	.041
Over 70			3.73 (3.18-4.20)	<.001	1.39 (1.23-1.56)	.009
Income						
Low	1.0					
Low-moderate					0.85 (1.10-0.53)	.273
Moderate					0.73 (1.24-0.21)	.395
Moderate-high					0.72 (1.05-0.47)	.841
High					0.81 (0.98-0.69)	.092
Place of residence						
Rural	1.0					

Urban					0.72 (1.70-0.14)	.627
Educational level						
≤6 years					2.26 (1.54-2.98)	.032
7–9 years					1.83 (0.91-3.01)	.333
10–12 years					1.24 (0.87-1.68)	.127
≥13 years	1.0					
Type of occupation						
Unemployed	1.0					
Employed					1.39 (0.98-1.77)	.442
Marital status						
Married	1.0					
Single & Widowed					1.86 (1.01-2.66)	.072
Private health insurance						
No	1.0					
Yes					0.83 (1.11-0.52)	.199
Economic activity						
No	1.0					
Yes					1.26 (0.84-1.67)	.227
Smoking						
Nonsmoker and ex-smoker	1.0					
Current smoker	1.44 (1.27-1.63)	<.01	1.26 (1.00-1.59)	.091	1.18 (0.82-1.68)	.181
Drinking						
2 drinks/month to 3 drinks/week	1.0					
4 drinks/week	1.59 (1.28-1.97)	<.01	1.10 (0.87-1.38)	.341	1.11 (0.88-1.41)	.502
Sedentary time						
Less than 9 hours	1.0					
9 hours or longer	1.01 (0.98-1.04)	.182	0.99 (0.96-1.02)	.459	0.99 (0.96-1.02)	.671
Walking time						
Walk rarely	1.0					
Walk moderately	0.73 (0.63-0.81)	.012	0.76 (0.56-0.97)	.028	0.76 (0.54-1.02)	.051
Walk high	0.78 (0.64-0.96)	.019	0.85 (0.71-0.96)	.037	0.86 (0.69-1.03)	.062
Constant term	0.291		0.005		0.006	

***p< .01, **p<.05, *p<.1

Model 2's results showed that smokers were 1.2 times more likely to have knee joint pain than nonsmokers. Additionally, those who walked moderately and often were less likely to have knee joint pain than those who walked rarely. What is worth noting here is that those who walked often were slightly more likely to have knee joint pain than those who walked moderately. In Model 3, which adjusted all control variables, those who walked often had a smaller effect size than those who walked moderately. Other variables than those mentioned above were not statistically significant.

Discussion

To summarize the above results, while smoking had a positive effect on the likelihood of knee joint pain, the effect was not statistically significant. Drinking also showed the same results as smoking. Sedentary time had a negative effect on knee joint pain, but the effect was not statistically significant. However, walking time was confirmed to have a negative effect on the prevalence of knee joint pain. More importantly, those with moderate-intensity walking time and those with high-intensity walking time showed different effects on preventing knee joint pain, suggesting that moderate-intensity walking and high-intensity walking basically lower the likelihood of knee joint pain, but the effect of high-intensity walking is lower than that of moderate-intensity walking.

In general, walking is considered to have an effect on preventing knee joint pain and knee arthritis or reducing pain. However, compared to the previous studies that found continuous walking exercise increased knee joint pain, or longer walking increased knee joint pain, the present study's results would also be consistent with these findings [21, 22]. Additionally, the present study's results were also consistent with those of a Korean study on those aged 55 years or older that as individuals became older, walking exercise would become more effective for knee joint pain than moderate-intensity exercise [23].

Considering the above results, effective walking exercise would refer to walk for no less than 30 minutes per day at least 3 times per week. Of course, various exercise programs show a positive effect on leading a better daily life and decreasing knee joint pain by increasing leg muscles [24-26]. According to the present study's results based on national-level data, moderate-intensity walking time would be more effective in preventing knee joint pain than high-intensity walking time. Considering that all other conditions are equal, effective walking exercise would be to walk for no less than 30 minutes per day at least 3 times per week.

Unlike previous research conducted with a small number of samples, a study based on big data collected by public institutions can be carried out to produce more generalized results [27, 28].

The following are the present study's limitations: First, as the present study is a cross-sectional study that evaluated the association between walking time and knee joint pain at the time of the survey, it is difficult to clearly identify the causal effect of walking on knee joint pain. Second, we did not consider eating habits and mental health factors, which may have had an effect on chronic diseases, in using the KNHANES. These limitations may be revisited by cohort studies or panel survey analyses in the future. A study that investigates the causal association between walking and knee joint pain with a more specific and systematic questionnaire survey is required in the future.

Conclusion

The present study used a logistic regression analysis and analyzed the effect of walking time in activities of daily living on knee joint pain based on data from the 6th 2013–2014 KNHANES. The evident results are that while increasing walking time led to a lower likelihood for knee joint pain, those with high-intensity walking time had a higher likelihood for knee joint pain than those with moderate-intensity walking time. These results suggest that walking exercise would be very helpful in preventing and improving osteo arthrosis, one of the leading chronic disorders among Koreans aged 50 years or older, and it would be important to conduct a wide range of follow-up studies in the future on various factors, types of exercise, and exercise duration.

Conflict of Interest

The authors state no conflict of interest.

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