Effects of weight change and physical activity on knee pain and health-related quality of life in East Asian women aged 50 years and older with knee osteoarthritis: a population-based study

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Abstract

Background This study aimed to investigate the effects of weight change and physical activity on the level of knee pain and health-related quality of life in East Asian women with knee osteoarthritis using population-based data. Methods A total of 564 women (mean age, 68.2 years, standard deviation, 8.9 years) aged 50 years or older with knee osteoarthritis (Kellgren-Lawrence grade ≥2) were included in the data analyses from the fifth Korea National Health and Nutrition Examination Survey. Data regarding the radiographic grade, weight change during the past year, physical activity, level of knee pain, and health-related quality of life (EuroQOL five-dimension [EQ-5D] index) were collected. Multiple regression analysis was performed to identify factors significantly affecting the level of knee pain and health-related quality of life in subgroups according to the body mass index (BMI) range (≤22.5, between 22.6 and 27.5, and >27.5 kg/m2). Result In women with 22.5 kg/m227.5 kg/m2, weekly hours of moderate-intensity activity showed significant negative correlation with EQ-5D. Conclusions The effects of weight change and physical activity on knee pain and health-related quality of life could be different according to BMI ranges. Well-designed interventions to improve both knee pain and health-related quality of life need to be investigated in future studies that would assess physical activity, diet, and weight changes.

Background

Knee osteoarthritis is one of the most prevalent orthopedic disorders that adversely affects the patients' health-related quality of life, especially in the elderly population(2-5)[1-4]. Knee pain is an important clinical parameter when determining the necessity of surgical treatment and the treatment outcomes[5-10]. Therefore, orthopedic surgeons need to understand the factors affecting the level of knee pain and quality of life in patients with knee osteoarthritis.

Previous studies showed that various factors could affect arthritic knee pain, including the radiographic grade of osteoarthritis, presence of spine or hip diseases, obesity, and even psychiatric disorders[11-17]. Obesity is known to affect arthritic pain by increasing mechanical load on the joint as well as by increasing inflammatory cytokine through the arachidonic pathway, which eventually could lead to development and progression of knee osteoarthritis[18-20]. Therefore, obesity has been acknowledged as an important modifiable factor that affects the prognosis of knee osteoarthritis[18, 21-26].

A study reported that weight loss and moderate activity were effective in improving function and pain in obese patients with knee osteoarthritis[18, 24, 26-28]. However, there is little evidence that weight loss is an effective treatment in nonobese patients, especially in the Asian population. Theoretically, body weight and physical activity could have complicated effects on the mechanical load on the joint, and their relationship could be a confounding factor when analyzing this effect.

This study aimed to investigate the effects of weight change and physical activity on knee pain and health-related quality of life in women with knee osteoarthritis (Kellgren-Lawrence grade ≥2) using population-based data.

Methods

Subjects

The Korean National Health and Nutrition Examination Survey (KNHNES) is a national population-based study conducted by the Korean Centers for Disease Control and Prevention annually from 1998. The subjects are noninstitutionalized civilians who were randomly selected through stratified, multistage probability samples, which were based on age, sex, and residence area. This study includes questionnaires regarding health behavior and nutrition intake and health examinations such as body weight, height, blood pressure measurements, and blood tests. Specific health examinations are included according to the demand of national healthcare policies. Knee osteoarthritis examination and survey were performed in 2011.

A total of 10,589 population-based subjects were invited to participate in the 2011 survey, and 8518 agreed to participate, with a response rate of 80.4%. Of these, 1956 women aged 50 years and older were included. Knee osteoarthritis was defined radiographically as Kellgren-Lawrence grade ≥2[7, 29, 30], which was evaluated by two skeletal radiologists. A total of 830 women with knee osteoarthritis were selected, and exclusion criteria were use of osteoarthritis medication, presence of

malignancies, and incomplete dataset. Finally, 564 women with knee osteoarthritis were analyzed after implementing the inclusion and exclusion criteria (Figure 1).

Written informed consent was obtained by the Korean Centers for Disease Control and Prevention from all participants. Approval from the ethical committee was exempted by the institutional review board at our hospital because this study utilized a publicly available database and did not have any potential violation of patient rights.

Data collection from the fifth KNHNES database

Demographic data including age, sex, body mass index (BMI), weight change in the past year (gain >10 kg, gain of 6–10 kg, gain of 3–6 kg, gain <3 kg, no change, loss <3 kg, loss of 3–6 kg, loss of 6–10 kg, and loss >10 kg) was collected. The parameters of height and weight were measured using standardized instruments, and BMI was calculated using the height and weight measurements. The percentage of weight change was calculated by dividing the weight change with body weight. Presence of malignant diseases and use of osteoarthritis medication were recorded using a health information questionnaire. The short form of the International Physical Activity Questionnaire[31] was used to evaluate the subjects' activity level, and weekly hours of vigorous-intensity, moderate-intensity, and walking activities were recorded.

Health-related quality of life was measured using the EuroQOL five-dimension (EQ-5D) index. The system comprises five dimensions including mobility, self-care, usual activities, pain/discomfort, and anxiety/depression[32, 33].

The knee osteoarthritis survey included severity of knee pain and radiographic examination. The severity of knee pain was evaluated using a 10-point numerical rating scale (NRS) (0=no pain, 10=severe pain). Knee X-rays were taken bilaterally with the subjects' weight-bearing using an SD 3000 Synchro Stand (Accele Ray, SYFM Co., Seoul, South Korea), and the radiographic images were digitally stored. Severity of radiographic knee osteoarthritis was evaluated using the Kellgren-Lawrence grading system[7, 29, 30](grade 0, no features of osteoarthritis; grade 1, small osteophytes of uncertain significance; grade 2, definite osteophytes without impairment of joint space; grade 3, definite osteophytes with moderate joint space reduction; grade 4, definite osteophytes with substantial joint space narrowing and subchondral bone sclerosis). Presence of knee osteoarthritis was defined as Kellgren-Lawrence grades 2, 3, and 4[7, 29, 30]. Radiographic evaluation was performed by two radiologists, and the agreement between the two was 85.2% for 81 randomly selected radiographic images with an intraclass correlation coefficient of 0.767 (95% confidence interval, 0.659 to 0.844). If a disagreement in radiographic findings between the two radiologists occurred, the higher grade was adopted.

Data analysis and statistics

Women with knee osteoarthritis were categorized into three groups according to BMI measurements: those with BMI≤22.5 kg/m^2, those with 22.5 kg/m^2<BMI≤27.5 kg/m^2, and those with BMI>27.5 kg/m^2. Descriptive statistics included mean and standard deviation (SD) for continuous variables and proportion for categorical variables. Normal distribution of the data was tested using the Kolmogorov-Smirnov test. Means and frequency were compared using analysis of variance (ANOVA) test and chi-square test among the three groups, respectively. Correlation between the variables was analyzed using Pearson's correlation coefficient or Spearman's correlation coefficient according to data normality.

Multiple regression analysis was performed to identify the variables that significantly contributed to the level of knee pain (NRS) and health-related quality of life (EQ-5D), which were dependent variables. Candidate independent variables were selected and included in the regression model when the variable showed $p<0.1$ in the correlation tests. All statistical analyses were performed using SPSS version 20.0 (IBM Corp., Armonk, NY, USA), with statistical significance set at $p<0.05$.

Results

The characteristics of the patients included in the analysis are given in Table 1.

In all subjects, the severity of radiographic osteoarthritis (Kellgren-Lawrence grade) ($p<0.001$) was the significant factor affecting the level of knee pain, whereas age ($p<0.001$) and level of knee pain ($p<0.001$) were the factors significantly affecting EQ-5D (Table 2). In the subgroup of women with BMI≤22.5 kg/m^2, Kellgren-Lawrence grade ($p<0.001$) was the significant factor affecting the level of knee pain, and age ($p<0.001$) and level of knee pain ($p<0.001$) significantly contributed to EQ-5D (Table 3). In the subgroup of women with 22.5 kg/m^2<BMI≤27.5 kg/m^2, the Kellgren-Lawrence grade ($p<0.001$) and percentage change of weight during the past year ($p=0.006$) were found to be significant factors affecting the level of knee pain. Age ($p=0.002$), level of knee pain ($p<0.001$), and weekly hours of walking ($p=0.018$) were the factors that significantly affected EQ-5D in this subgroup (Table 4). In the subgroup of women with BMI>27.5 kg/m^2, age ($p=0.031$) was the significant factor affecting the level of knee pain, and level of knee pain ($p=0.002$) and weekly hours of moderate-intensity activity ($p=0.010$) were the factors that significantly contributed to EQ-5D (Table 5).

For the correlation between activity and weight change, weekly hours of walking was the only factor that was significantly correlated with percentage change of weight during the past year ($r=0.215$, $p=0.032$) in the subgroup of women with BMI>27.5 kg/m^2. There was no significant correlation between activity and weight change in the other subgroups.

Discussion

This study investigated the factors affecting level of knee pain and health-related quality of life (EQ-5D), focusing on weight change and activity in community-based women aged 50 years and older with knee osteoarthritis. Important confounding factors were excluded from the data, such as presence of malignancy and osteoarthritis medication. We analyzed the data as subgroups stratified according to BMI. Weight change and activity showed different effects on level knee pain and health-related quality of life according to BMI subgroups.

In our whole cohort, BMI showed no significant correlation with knee pain or health-related quality of life. This is contrary to clinical consensus and previous study results that obesity has an important factor in the development and progression of osteoarthritis in terms of mechanical loading and biochemical pathway affecting inflammatory processes related with lipid metabolism[18, 26, 28, 34]. The authors considered that BMI is a critical factor in pain and health-related quality of life and stratified the whole cohort according to BMI, specifically designed for East Asian Women[35]; the most optimal BMI range (showing the lowest mortality), above and below the optimal range.

In our study, contrary to previous studies[28, 34], weight change during a year did not show significant correlation with the level of knee pain for the whole group of women aged 50 years and older with knee osteoarthritis (Kellgren-Lawrence grade ≥2). The effect of weight change on knee pain showed differences according to BMI ranges. Weight change did not significantly affect the level of knee pain in women above and below the optimal range of BMI, but it showed significant effect on the level of knee pain in women within the optimal range of BMI (22.5 kg/m^2<BMI≤27.5 kg/m^2). This result is not in concurrence with previous studies that showed that weight loss improved physical function and pain in overweight women with knee osteoarthritis[28, 34]. This difference might have been caused by the different characteristics of the study cohort or the effect of combined intervention such as exercise and diet. Therefore, weight loss alone might not decrease knee pain without appropriate exercise or concomitant intervention in obese patients with knee osteoarthritis.

The amount of activity did not show any relationship with the level of knee pain in this community-based observational study, but it showed significant relationship with health-related quality of life. In the subgroup of women with 22.5 kg/m^2<BMI≤27.5 kg/m^2, weekly hours of walking showed significant positive correlation with EQ-5D. In the subgroup of women with BMI>27.5 kg/m^2, weekly hours of moderate-intensity activity showed significant negative correlation with EQ-5D. However, in both subgroups, the amount of activity did not show significant correlation with the weight changes. The amount of diet intake is considered to have an important role in weight changes[36-38].

There are some limitations to this study. First, this study was essentially a cross-sectional study depending on health-related questionnaire and specific examination. Therefore, causal relationship between the independent and dependent variables is not certain. Further longitudinal study with relevant hypothesis is required to verify the causality of the variables. Second, we excluded confounding factors such as presence of malignancy and osteoarthritis medication because these variables could significantly

affect the level of knee pain. However, this exclusion might not reflect the usual clinical situation, although the study setting could evaluate the factors affecting knee pain more precisely in a community-based population without any medical intervention for knee osteoarthritis.

In conclusion, the amount of weight change and physical activity could affect the level of knee pain and health-related quality of life separately. Our study results suggested that weight reduction via walking exercise could reduce knee pain and improve health-related quality of life in the subgroup of East Asian women with optimal range of BMI with knee osteoarthritis. However, the specific type of physical activity could impede the patients' health-related quality of life although it might help reduce the patient's weight. Therefore, more sophisticated intervention is required regarding physical activity and weight loss according to BMI ranges in women with knee osteoarthritis. Future studies with strictly designed diet and physical activity are required to elucidate the relationships among weight loss, knee pain, and health-related quality of life.

Conclusions

The effect of weight change on knee pain could be different according to BMI ranges. Walking activity could improve the quality of life in women with optimal BMI range. Moderate intensity activity could impair the quality of life in obese women.

Abbreviations

BMI: Body mass index; EQ-5D: EuroQOL five-dimension; NRS: Numerical rating scale; ANOVA: Analysis of variance

Declarations

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Authors' Contributions

All authors on this manuscript (CBC, YC, SBK, CYC, MSP and KML) made significant contributions to the study design. CBC, SBK and CYC were involved in the conception and design of the study, acquisition of data. CBC, YC, MSP and KML were involved in the analysis and interpretation of data, as well as drafting the manuscript. All authors gave final approval of the version to be published.

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Availability of data and materials

The data set supporting the conclusion of this article is available on request to the corresponding author.

Ethics approval and consent to participate

Not applicable

Consent to publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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Tables

Table 1. Data summary

	All subjects with knee osteoarthritis (n=564)	BMI subgroups			
		BMI≤22.5 kg/m^2 (n=139)	22.5 kg/m^2<BMI≤27.5 kg/m^2 (n=326)	BMI>27.5 kg/m^2 (n=99)	p-Value
Age (years)	68.2 (8.9)	71.6 (9.0)	67.6 (8.7)	65.6 (8.2)	<0.001
BMI (kg/m^2)	24.8 (3.6)	20.7 (1.4)	25.0 (1.4)	30.2 (3.3)	<0.001
Percentage change of body weight (%)	-1.0 (4.7)	-2.6 (5.9)	-0.5 (4.2)	-0.3 (4.1)	<0.001
Kellgren-Lawrence grade (2/3/4)	257/227/80	70/52/17	154/127/45	33/48/18	0.101
Activity (weekly hours)					
Vigorous intensity	0.88 (3.8)	0.94 (4.7)	0.91 (3.8)	0.67 (2.1)	0.839
Moderate intensity	1.2 (3.9)	0.76 (2.2)	1.49 (4.5)	1.1 (3.3)	0.166
Walking	3.4 (5.1)	3.5 (5.0)	3.54 (5.4)	2.5 (4.0)	0.208
Level of knee pain	2.02 (3.33)	1.87 (3.34)	1.92 (3.25)	2.57 (3.56)	0.199
EQ-5D	0.867 (0.174)	0.842 (0.217)	0.879 (0.159)	0.858 (0.148)	0.093

Values are presented as mean (standard deviation) or n.

Table 2. Multiple regression analysis in all subjects with knee osteoarthritis aged 50 years and older

Level of knee pain (dependent variable)						EQ-5D (dependent variable)					
	Nonstandardized		Standardized beta	t	p-Value		Nonstandardized		Standardized beta	t	V-value
	B	Standard error					B	Standard error			
Age	0.026	0.016	0.069	1.639	0.102	Age	-0.004	0.001	-0.204	-5.254	<0.001
Kellgren-Lawrence grade	1.22	0.197	0.259	6.187	<0.001	Level of knee pain	-0.018	0.002	-0.345	-8.79	<0.001
Percentage change of weight	-0.026	0.029	-0.037	-0.901	0.368	Kellgren-Lawrence grade	-0.018	0.01	-0.072	-1.783	0.075
Weekly hours of walking	-0.043	0.026	-0.066	-1.613	0.107	Weekly hours of walking	0.002	0.001	0.047	1.231	0.219
Coefficient	-2.896	1.097	-	-2.641	0.008	Coefficient	1.217	0.053	-	22.887	<0.001

Table 3. Multiple regression analysis in the subgroup of women with BMI≤22.5 kg/m^2 aged 50 years and older with knee osteoarthritis

Level of knee pain (dependent variable)						EQ-5D (dependent variable)					
	Nonstandardized		Standardized beta	t	p-Value		Nonstandardized		Standardized beta	t	p-Value
	B	Standard error					B	Standard error			
BMI	-0.192	0.2	-0.08	-0.962	0.338	Age	-0.007	0.002	-0.282	-3.733	<0.001
Kellgren-Lawrence grade	1.539	0.399	0.32	3.86	<0.001	Level of knee pain	-0.021	0.005	-0.33	-4.184	<0.001
Coefficient	1.824	4.522	-	0.403	0.687	Kellgren-Lawrence grade	-0.036	0.025	-0.116	-1.455	0.148
						Coefficient	1.465	0.135	-	10.851	<0.001

Table 4. Multiple regression analysis in the subgroup of women with 22.5 kg/m^2<BMI≤27.5 kg/m^2 aged 50 years and older with knee osteoarthritis

Level of knee pain (dependent variable)						EQ-5D (dependent variable)					
	Nonstandardized		Standardized beta	t	p-Value		Nonstandardized		Standardized beta	t	p-Value
	B	Standard error					B	Standard error			
Age	0.028	0.021	0.075	1.351	0.178	Age	-0.003	0.001	-0.161	-3.081	0.002
Kellgren-Lawrence grde	1.208	0.253	0.263	4.765	<0.001	Level of knee pain	-0.019	0.003	-0.382	-7.411	<0.001
Percentage change of weight	-0.114	0.041	-0.146	-2.763	0.006	Kellgren-Lawrence grade	-0.005	0.012	-0.023	-0.433	0.665
Coefficient	-3.26	1.366	-	-2.387	0.018	Weekly hours of walking	0.003	0.001	0.118	2.384	0.018
						BMI	-0.008	0.006	-0.069	-1.404	0.161
						Coefficient	1.314	0.158	-	8.293	<0.001

Table 5. Multiple regression analysis in the subgroup of women with BMI>27.5 kg/m^2 aged 50 years and older with knee osteoarthritis

Level of knee pain (dependent variable)						EQ-5D (dependent variable)					
	Nonstandardized		Standardized beta	t	p-Value		Nonstandardized		Standardized beta	t	p-Value
	B	Standard error					B	Standard error			
Age	0.094	0.043	0.217	2.186	0.031	Age	-0.003	0.002	-0.169	-1.759	0.082
Coefficient	-3.584	2.836	-	-1.264	0.209	Level of knee pain	-0.013	0.004	-0.301	-3.25	0.002
						Kellgren-Lawrence grade	-0.035	0.02	-0.166	-1.751	0.083
						Weekly hours of moderate intensity activity	-0.011	0.004	-0.238	-2.63	0.01
						Coefficient	1.201	0.112	-	10.695	<0.001

Figures

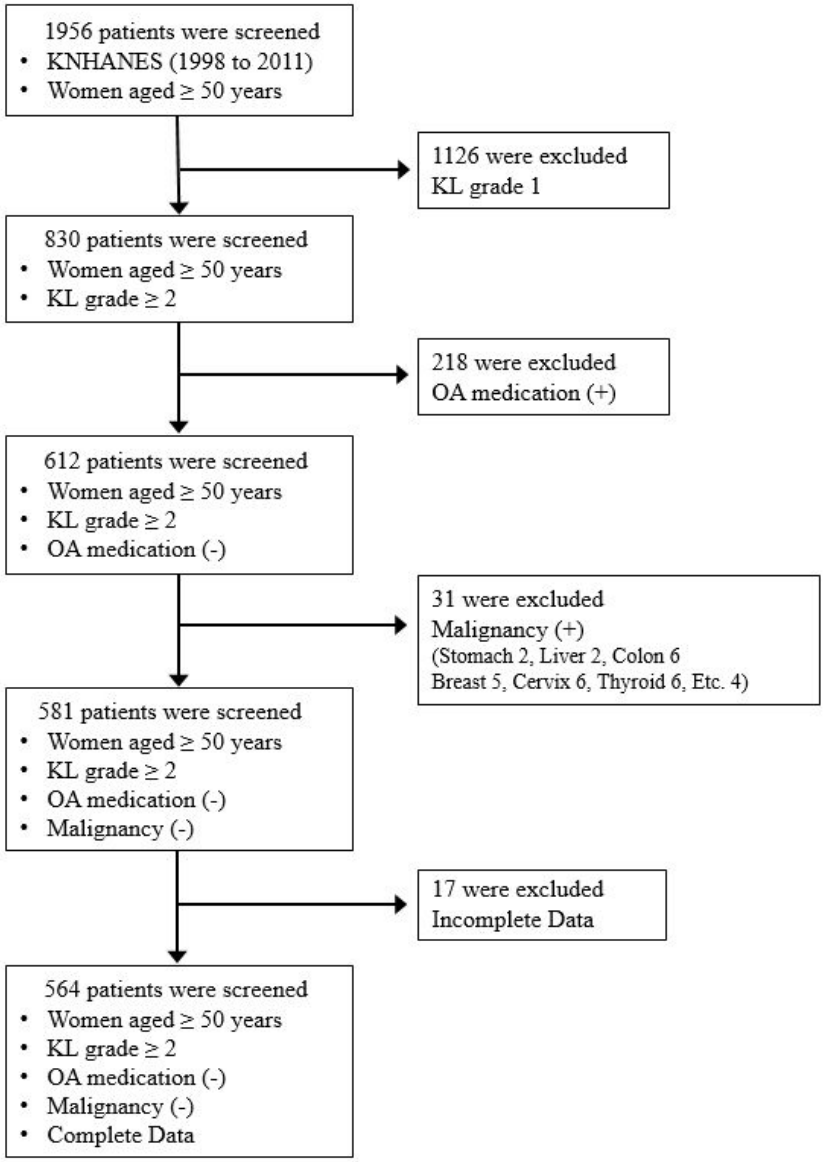

Figure 1

Flow diagram of the inclusion and exclusion criteria for the Korea National Health and Nutrition Examination Survey (KNHNES). A total of 564 women aged 50 years or older were included.