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Clinical Study

Walking more than 90 minutes/week was associated with a lower risk of self-reported low back pain in persons over 50 years of age: a cross-sectional study using the Korean National Health and Nutrition Examination Surveys

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Abstract

BACKGROUND CONTEXT: Physical activity, such as muscle strengthening and aerobic exercise, has been found to be effective for low back pain (LBP). However, the association between weekly walking duration and LBP in the general population remains poorly understood.
OBJECT: This study aimed (1) to analyze the association between walking and LBP and (2) to examine this association according to walking duration and overall walking days per week in a general population over 50 years of age using a representative sample of Korean adults.
STUDY DESIGN: Cross-sectional study.
PATIENT SAMPLE: Data from the Korea National Health and Nutrition Examination Surveys V and VI, performed from 2010 to 2015.
OUTCOME MEASURES: Multiple logistic regression analysis was performed to determine the association between walking days and duration and LBP. Analysis was restricted to participants aged over 50 years who responded to surveys on LBP and walking activity.
METHODS: National health and nutrition examination surveys were performed in the Korean general population (N=48,482) from 2010 to 2015. LBP status was surveyed using a self-reported questionnaire form ("Have you complained of LBP for more than 30 days during the past 3 months?"). Daily walking activity (low-intensity activity) was evaluated using the following two questions: (1) "During the last 7 days, on how many days did you walk for at least 10 minutes at a time? This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure." (2) "How much time did you usually spend walking on each of those days?" Walking duration per day was classified into two categories: over 30 min/day and over 1 h/day. Overall walking days per week were categorized into <3, 3–4, and ≥5 days/week. Basic characteristics, comorbidities, socioeconomic status, and other variables were used to create multiple logistic regression models. No sources of funding and no conflicts of interest were associated with this study.

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RESULTS: Walking for more than 3 days per week for over 30 minutes at a time was negatively associated with LBP in the unadjusted (adjusted odds ratio [aOR]: 0.65, p<.001) and fully adjusted logistic regression models (aOR: 0.79, p<.001). Similarly, walking for more than 5 days per week for over 1 hour at a time was negatively associated with LBP in the unadjusted (aOR: 0.62, p<.001) and fully adjusted logistic regression models (aOR: 0.76, p<.001). The risk of LBP decreased with increasing walking days and duration.

CONCLUSIONS: Our study showed that longer walking duration was associated with a lower risk of LBP using a cross-sectional health survey in the Korean general population. Regular walking with a longer duration for more than 3 days/week is significantly associated with a lower risk of LBP in the general population aged over 50 years.

Keywords: Low back pain; General population; Walking; KNHANES; Physical activity; Risk factors.

Introduction

Low back pain (LBP) is one of the most common musculoskeletal problems affecting the quality of life in the elderly [1–3], with up to 80% of the general population having been reported to experience LBP at least once in their lifetime [2,3].

The complex and diverse causes of LBP remain unclear. LBP is closely related to anatomical problems of the spine, such as disc herniation, lumbar stenosis, and trauma. However, other environmental factors also showed associations with LBP [4]. Among these factors, reduced physical activity is highly related to LBP [5–7] and can negatively impact health status and quality of life [8].

The American Physical Therapy Association guidelines recommend moderate- to high-intensity exercise (eg, jogging, running, and push-ups) for patients with LBP without generalized pain and low-intensity or submaximal activity for patients with generalized pain [9]. Walking is one of the physical activities that does not require special training or equipment and can be integrated easily into daily life [10–13]. Recent meta-analyses reported that walking exercise is recommended to reduce pain and disability in the management of chronic LBP [14,15].

Based on these theoretical considerations, this study aimed (1) to analyze the association between walking and LBP and (2) to examine this association according to walking duration and overall walking days per week in a general population over 50 years of age using a representative sample of Korean adults.

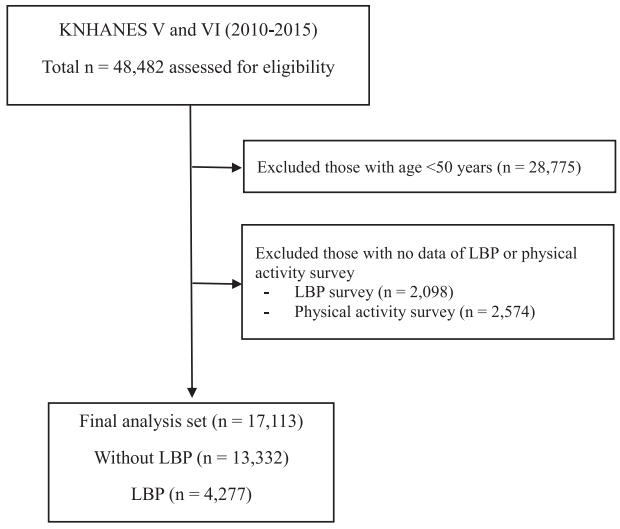
Materials and methods

Study participants

The Korea National Health and Nutrition Examination Survey (KNHANES) V and VI were performed from 2010 to 2012 and from 2013 to 2015, respectively. The KNHANES has been annually performed since 1998 by the Korea Centers for Disease Control and Prevention to evaluate the health and nutritional status of the Korean population. This survey is designed to evaluate the representative data of Korea using a multistage clustered and stratified random sampling method with proportional distribution according to geographic area, sex, and age. The survey participants are not annually monitored owing to random sampling every year. The KNHANES evaluates health surveys, health examinations, and nutrition surveys performed by experienced interviewers, registered nurses, and laboratory technicians [16]. From 2010 to 2015, the KNHANES V and VI were completed in 48,482 participants. In this study, participants under 50 years of age (the KNHANES V and IV does not evaluate and/or provide data on this age group) and those who did not respond to LBP and physical activity surveys were excluded. Of 48,482 participants in the KNHANES from 2010 to 2015, a total of 17,113 participants were included in our study (Fig. 1).

Definitions of low back pain and walking activity

The presence of LBP was defined as a positive response or "yes" answer to the health survey question "Have you complained of LBP for more than 30 days during the past 3 months?" Daily walking activity (low-intensity activity)



KNHANES, Korea National Health and Nutrition Examination Surveys; LBP, low back pain

Fig. 1. Flow diagram of inclusion and exclusion of subjects from the Korea National Health and Nutrition Examination Surveys (2010–2015).

was evaluated using the International Physical Activity Questionnaires–short form [17], which measures walking activity through the following two questions: (1) "During the last 7 days, on how many days did you walk for at least 10 minutes at a time? This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure." (2) "How much time did you usually spend walking on each of those days?" Walking duration per day was classified into two categories: (1) over 30 min/day and (2) over 1 h/day. Overall walking days per week were categorized into (1) <3 and 3–7 days/week and (2) <3, 3–4, and ≥5 days/week.

Characteristics of the study population

The characteristics of the study population, including socioeconomic status, medical history (eg, hypertension, diabetes), nutritional status, and other characteristics, were surveyed by health interviewers. Among these characteristics, we only used the demographic and socioeconomic data related to LBP, as described below.

Basic demographics, such as age, sex, height, weight, and body mass index, were analyzed. Smoking status was dichotomized into current or non-/ex-smoker, whereas alcohol consumption was divided into none, ≤1 drink/month, 2 drinks/month to 3 drinks/week, and ≥4 drinks/week. Current occupation was divided into five categories: unemployed (eg, housewife, student); office worker (eg, professional, manager); sales and services; machine fitting and simple labor (eg, device and machine operator, technician, and low-level laborer); and agriculture, forestry, and fishery [18]. Household income level was categorized into quartiles: low, low-moderate, moderate-high, and high. Educational level was categorized into the following four groups: ≤6 years (elementary school), 7–9 years (middle school), 10–12 years (high school), and ≥13 years (college or university). Comorbidities in the population included hypertension, diabetes mellitus, chronic kidney disease, dyslipidemia, ischemic heart disease (myocardial infarction, angina), stroke, liver cirrhosis, chronic hepatitis B or C, major cancers (lung, stomach, liver, colon, breast, or uterine cervical), asthma, pulmonary tuberculosis, depression, and arthritis. These comorbidities were counted and divided into three groups: none, one, and more than two.

Statistical analysis

Statistical analysis was performed using Stata/MP 15.0 (Stata Statistical Software: Release 15; StataCorp LLC, College Station, TX, USA). Continuous variables were presented as mean ± standard deviation, whereas categorical variables were presented as numbers and percentages. Statistical significance was considered at two-tailed p value <.05. Odds ratios (ORs) with corresponding 95% confidence interval were accordingly calculated. In order to decrease sampling bias, sampling weights were applied to the study population when analyzing statistics.

Basic characteristics of the study population with or without LBP were analyzed using several statistical methods, including Student's *t*-test for continuous variables and the chi-squared test for categorical variables. Multiple logistic regression analysis was used to calculate the rates of association between LBP and walking days. In addition, a test for trend after logistic regression was used to analyze whether there was a linear trend in the association between walking days and LBP. We analyzed the ORs for crude and adjusted models. The crude model was analyzed only to assess the association between LBP and walking days. Moreover, the adjusted model was divided into two models, namely model 1, which was adjusted for age and sex, and model 2, which was fully adjusted for demographics and socioeconomic status using backward stepwise selection at a significance level of 0.05. The adjusted variables which used in model 2 were as follows: age, sex, height, weight, smoking status, alcohol consumption, educational level, occupation, household income, and number of comorbidities.

Ethics statement

The KNHANES V and VI were approved by the institutional review board of the Korea Centers for Disease Control and Prevention (approval no. 2010-02CON-21-C, 2011-02CON-06-C, 2012-01EXP-01-2C, 2013-07CON-03-4C, 2013-12EXP-03-5C). Informed consent for participation in the survey was obtained from all participants.

Results

Characteristics of the study population according to low back pain

The basic characteristics of the study population are shown in Table 1. A total of 17,113 participants (13,332 without LBP; 4,277 with LBP) were finally analyzed. Approximately 54.1% and 73.2% of participants with LBP spent less than 3 days/week walking for over 30 minutes and 1 hour, respectively. Other clinical characteristics were significantly different between participants with and without LBP (Table 1).

Association between walking days and low back pain

The association between walking days and LBP is presented in Table 2. Walking for more than 3 days/week for over 30 minutes was associated with lower ORs than walking for less than 3 days, and a clear negative relationship was found between walking duration and LBP. Walking for more than 5 days/week for over 30 minutes and 1 hour showed was associated with lower ORs than walking for 3–4 days. The ORs for LBP linearly decreased with increasing walking days in the crude and two-adjusted model (p for trend <.001).

Table 1
Characteristics of the study population according to low back pain

Variables	Without LBP (N = 13,332)	LBP (N = 4,227)	p
Age, year	63.1 (8.8)	67.3 (9.3)	<.001
Age, N (%)			
50−59	5410 (40.6%)	1047 (24.5%)	<.001
60−69	4464 (33.5%)	1292 (30.2%)	
70−79	2887 (21.7%)	1503 (35.1%)	
≥80	571 (4.4%)	435 (10.1%)	
Gender, N (%)			
Male	6418 (48.1%)	1077 (25.2%)	<.001
Female	6914 (51.9%)	3200 (74.8%)	
Height, cm	160.3 (8.7)	155.6 (8.6)	<.001
Weight, kg	61.8 (10.2)	58.9 (10.1)	<.001
BMI, kg/m^2	24.0 (3.1)	24.3 (3.4)	<.001
Obesity, N (%)*			
Underweight (<18.5)	353 (2.7%)	125 (2.9%)	.003
Normal (18.5−24.9)	8324 (62.6%)	2548 (59.7%)	
Obese (>25)	4629 (34.8%)	1598 (37.4%)	
Smoking status, N (%)			
Nonsmoker or ex-smoker	11069 (83.9%)	3714 (88.4%)	<.001
Current smoker	2129 (16.1%)	485 (11.6%)	
Alcohol status, N (%)			
None	2359 (22.0%)	921 (30.8%)	<.001
≤1 drink/month	3329 (31.1%)	1016 (34.0%)	
2 drinks/month to 3 drinks/week	3799 (35.5%)	790 (26.4%)	
≥4 drinks/week	1224 (11.4%)	265 (8.9%)	
Occupation, N (%)			
Unemployed (Student, housewife, etc.)	6171 (46.5%)	2521 (59.5%)	<.001
Office work	1348 (10.2%)	161 (3.8%)	
Sales and services	1438 (10.8%)	336 (7.9%)	
Agriculture, forestry and fishery	1422 (10.7%)	572 (13.5%)	
Machine fitting and simple labor	2889 (21.8%)	650 (15.3%)	
Household income, N (%)†			
Low	3427 (25.9%)	1979 (46.6%)	<.001
Low-moderate	3535 (26.8%)	1030 (24.3%)	
Moderate-high	3021 (22.9%)	635 (15.0%)	
High	3227 (24.4%)	599 (15.3%)	
Education level, N (%)‡			
≤6 years	5251 (39.5%)	2787 (65.7%)	<.001
7−9 years	2407 (18.1%)	605 (14.3%)	
10−12 years	3612 (27.2%)	606 (14.3%)	
≥13 years	2008 (15.1%)	243 (5.7%)	
Walking days, ≥30 minutes, N (%)§			
<3 days	5824 (43.7%)	2312 (54.1%)	<.001
3−4 days	2328 (17.5%)	610 (14.3%)	
≥5 days	5180 (38.9%)	1355 (31.7%)	
Walking days, ≥1 hours, N (%)‖			
<3 days	8392 (62.9%)	3129 (73.2%)	<.001
3−4 days	1409 (10.6%)	328 (7.7%)	
≥5 days	3531 (26.5%)	820 (19.2%)	
Comorbidities, N (%)¶			
0	8484 (63.6%)	2296 (53.7%)	<.001
1	2160 (16.2%)	592 (13.8%)	
≥2	2688 (20.2%)	1389 (32.5%)	

Numeric parameters are expressed as mean and standard deviation in parentheses.
Categorical parameters are expressed as counts and percentages in parentheses.
LBP, low back pain; BMI, body mass index.
* Body mass index was categorized into underweight (<18.5 kg/m^2), normal (18.5−24.9 kg/m^2), and obese (≥25.0 kg/m^2).
† Household income level was calculated by dividing the total household monthly income with the obtained levels then grouped into quartiles.
‡ Educational level was divided into the following four groups: ≤6 years (elementary school), 7−9 years (middle school), 10−12 years (high school), and ≥13 years (college or university).
§ Number of days walking more than 30 minutes at a time for a week.
‖ Number of days walking more than 1 hour at a time for a week.
¶ Number of major comorbidities: hypertension, diabetes mellitus, dyslipidemia, ischemic heart disease (myocardial infarction, angina), stroke, liver cirrhosis, major cancers (lung, stomach, liver, colon, breast, or uterine cervical), asthma, pulmonary tuberculosis, arthritis, or chronic kidney disease.

Table 2
Association between walking days and low back pain using multiple logistic regression

	Unadjusted			Model 1			Model 2		
	OR	95% CI	p Value	OR	95% CI	p Value	OR	95% CI	p Value
Walking days, ≥30 minutes*									
<3	1			1			1		
3–7	0.65	0.61–0.70	<.001	0.72	0.67–0.78	<.001	0.79	0.72–0.86	<.001
Walking days, ≥30 minutes*									
<3	1			1			1		
3–4	0.66	0.60–0.73	<.001	0.76	0.69–0.85	<.001	0.83	0.73–0.94	.004
≥5	0.66	0.61–0.71	<.001	0.74	0.68–0.80	<.001	0.79	0.72–0.87	<.001
p for trend			<.001			<.001			<.001
Walking days, ≥1 hours†									
<3	1			1			1		
3–4	0.62	0.55–0.71	<.001	0.75	0.66–0.86	<.001	0.78	0.67–0.91	.001
≥5	0.62	0.57–0.68	<.001	0.73	0.67–0.80	<.001	0.76	0.69–0.85	<.001
p for trend			<.001			<.001			<.001

OR, Odds ratio; 95% CI, 95% confidence interval.

* Number of walking days per week the subject walked over 30 minutes at a time was divided into two or three categories.

† Number of walking days per week the subject walked over 1 hour at a time was divided into three categories.

Model 1 was adjusted by age, and sex.

Model 2 was fully adjusted by age, sex, height, weight and other environmental factors such as smoking, alcohol consumption, education, occupation, household income, comorbidities.

Discussion

The most important finding of our study was that walking is independently associated with fewer instances of self-reported LBP. We analyzed walking and other several cofounders in 17,113 participants with LBP and determined that walking for more than 3 days/week for over 30 minutes at a time was significantly associated with a lower risk of LBP, taking several confounding factors into account. Further, when considering walking for more than 5 days/week for over 1 hour at a time, a more significant negative relationship was found between walking and LBP. Thus, our study indicates a strong relationship between walking duration and LBP in the Korean general population over 50 years of age.

Physical activity, such as muscle-strengthening or aerobic exercises, is a good pain reduction method for patients with LBP [19,20]. The American College of Sports Medicine recommends that physical activity be performed three to five times per week for over 30 minutes to maintain good health [21]. However, up to 70% of patients with LBP know that exercise improves LBP and maintains good health but do not exercise regularly [22,23]. Walking, the simplest form of physical activity, is frequently recommended for improving health [12,14,15]. Walking is more cost-effective than other exercises, is easily accessible, and does not require special equipment and training. Further, it increases cardiac capacity, maximum oxygen uptake, and general physical activity and carries a lower risk of injury than running or sport participation [12]. Among several types of exercise, unsupervised walking is an option to reduce LBP-related disability, but scarce evidence supports its use in the management of LBP [24]. Recent meta-analyses showed that walking activity improves LBP, disability, and fear avoidance similar to other exercises [14,15]. However, high-quality studies are required to clarify walking duration, frequency, and types for LBP improvement [14,15].

Encouraging patients with LBP to walk could enable them to exercise even at a minimum level. Patients with LBP are more likely to follow a simple walking exercise than a supervised exercise program because of the simplicity of walking [25,26]. However, the required exercise duration for a certain period per week remains unclear. In our study, we divided walking duration per day into more than 30 minutes and more than 1 hour. Moreover, overall walking days per week were categorized into three parts: <3, 3–4, and ≥5 days/week. Our analysis consequently found that walking for more than 3 days/week for over 30 minutes was closely associated with a lower risk of LBP and that exercise for over 1 hour per day more than 5 times per week exhibited an even more significant negative relationship with LBP.

There are two points to consider when attempting to explain this relationship. First, LBP itself prevents regular walking in patients, which is considered to be a fear-avoidance belief. A previous study reported that reducing fear-avoidance beliefs may help avoid delayed recovery and chronicity [27]. Second, LBP is caused by low walking activity. Therefore, regular walking can be considered to be a form of pain relief [14,15].

To the best of our knowledge, this is the first study assessing the relationship between walking and LBP according to walking duration and days in the Korean general population aged over 50 years. One of the strengths of our study is that we surveyed walking duration and days and LBP in a large number of Korean participants. The use of the KNHANES data provided representative samples of the Korean general population. This has strengthened the

external validity of our findings and their application to the general population and patients with LBP.

Our study has some limitations. First, this study was a cross-sectional analysis using the KNHANES data. Therefore, we cannot assess the causal relationship between walking and LBP and can only analyze their association. However, the KNHANES datasets were designed to minimize sampling errors from the Korean general population, and the results could be considered highly representative. We hope to conduct a future study that includes a representative general population with increased generalizability, and enables a more precise grasp of LBP. Second, the surveys used in the KNHANES did not evaluate the degree or severity of LBP, which is usually measured using a numeric rating scale and quality of life or disability scores. LBP itself is a subjective symptom. Although the questionnaire lacked the ability to assess the LBP status in detail (severity, source, or duration of LBP), we believed that it was appropriate for determining the presence of LBP. Third, the association between walking and LBP may be dependent on ethnicity. Our dataset is a nationwide health and nutrition examination survey of the Korean general population. Hence, caution in extrapolating our results to other ethnicities is warranted. Fourth, in the KNHANES dataset from 2010 to 2015, the survey for LBP was performed in a population over 50 years of age. If the population under 50 years of age had been included, our study results might have been different. Fifth, walking duration was measured using a self-reported questionnaire form. This self-reported form could generate recall bias, which is a potential disadvantage in that survey participants may have reported longer walking duration than what would have been observed using an objective method [28]. Nevertheless, this self-reported form has good validity and reliability with objective methods [17]. Therefore, our study results may be sufficiently meaningful to detect an association. Finally, basic demographics were different according to LBP. To control for several covariates that could affect LBP, we performed multiple logistic regression analysis to assess covariates. We believe that this statistical method was adequate to identify the risk or protective factors [29].

Conclusions

Our study showed that longer walking duration was associated with a lower risk of LBP using a cross-sectional health survey performed in the Korean general population. Regular walking with a longer duration for more than 3 days/week is significantly associated with a lower risk of LBP in the general population aged over 50 years. However, we were unable to confirm a causal relationship. Therefore, further large-scale cohort studies on the association between physical activity and LBP considering other risk factors are required. Clinicians should be aware that regular walking for over 30 minutes 3 times per week is negatively related with LBP; therefore, they should advise patients with LBP to increase their walking duration for optimal LBP improvement.

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Reference

[1] Balague F, Mannion AF, Pellise F, Cedraschi C. Non-specific low back pain. Lancet 2012;379:482–91.
[2] Hong JY, Song KS, Cho JH, Lee JH. An updated overview of low back pain management in primary care. Asian Spine J 2017;11:653–60.
[3] Ganesan S, Acharya AS, Chauhan R, Acharya S. Prevalence and risk factors for low back pain in 1,355 young adults: a cross-sectional study. Asian Spine J 2017;11:610–7.
[4] Sribastav SS, Long J, He P, et al. Risk factors associated with pain severity in patients with non-specific low back pain in Southern China. Asian Spine J 2018;12:533–43.
[5] Shiri R, Coggon D, Falah-Hassani K. Exercise for the prevention of low back pain: systematic review and meta-analysis of controlled trials. Am J Epidemiol 2018;187:1093–101.
[6] Alnojeidi AH, Johnson TM, Richardson MR, Churilla JR. Associations between low back pain and muscle-strengthening activity in U.S. adults. Spine 2017;42:1220–5. (Phila Pa 1976).
[7] Smuck M, Kao MC, Brar N, Martinez-Ith A, Choi J, Tomkins-Lane CC. Does physical activity influence the relationship between low back pain and obesity? Spine J 2014;14:209–16.
[8] Landmark T, Romundstad P, Borchgrevink PC, Kaasa S, Dale O. Associations between recreational exercise and chronic pain in the general population: evidence from the HUNT 3 study. Pain 2011;152:2241–7.
[9] Delitto A, George SZ, Van Dillen LR, et al. Low back pain. J Orthop Sports Phys Ther 2012;42:A1–A57.
[10] Tully MA, Cupples ME, Hart ND, et al. Randomised controlled trial of home-based walking programmes at and below current recommended levels of exercise in sedentary adults. J Epidemiol Community Health 2007;61:778–83.
[11] Park SM, Kim HJ, Jeong H, et al. Longer sitting time and low physical activity are closely associated with chronic low back pain in population over 50 years of age: a cross-sectional study using the sixth Korea National Health and Nutrition Examination Survey. Spine J 2018 pii: S1529-9430(18)30157-8. https://doi.org/10.1016/j.spinee.2018.04.003.
[12] Hootman JM, Macera CA, Ainsworth BE, Martin M, Addy CL, Blair SN. Association among physical activity level, cardiorespiratory fitness, and risk of musculoskeletal injury. Am J Epidemiol 2001;154:251–8.
[13] Siegel PZ, Brackbill RM, Heath GW. The epidemiology of walking for exercise: implications for promoting activity among sedentary groups. Am J Public Health 1995;85:706–10.
[14] Sitthipornvorakul E, Klinsophon T, Sihawong R, Janwantanakul P. The effects of walking intervention in patients with chronic low back pain: a meta-analysis of randomized controlled trials. Musculoskelet Sci Pract 2018;34:38–46.
[15] Vanti C, Andreatta S, Borghi S, Guccione AA, Pillastrini P, Bertozzi L. The effectiveness of walking versus exercise on pain and function in chronic low back pain: a systematic review and meta-analysis of randomized trials. Disabil Rehabil 2017;1–11.

[16] Kweon S, Kim Y, Jang MJ, et al. Data resource profile: the Korea National Health and Nutrition Examination Survey (KNHANES). Int J Epidemiol 2014;43:69–77.
[17] Chun MY. Validity and reliability of Korean version of international physical activity questionnaire short form in the elderly. Korean J Fam Med 2012;33:144–51.
[18] Punnett L, Pruss-Utun A, Nelson DI, et al. Estimating the global burden of low back pain attributable to combined occupational exposures. Am J Ind Med 2005;48:459–69.
[19] Gordon R, Bloxham S. A systematic review of the effects of exercise and physical activity on non-specific chronic low back pain. Healthcare (Basel) 2016;4:22.
[20] Noormohammadpour P, Kordi M, Mansournia MA, Akbari-Fakhrabadi M, Kordi R. The role of a multi-step core stability exercise program in the treatment of nurses with chronic low back pain: a single-blinded randomized controlled trial. Asian Spine J 2018;12:490–502.
[21] American College of Sports Medicine Position Stand. The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. Med Sci Sports Exerc 1998;30:975–91.
[22] Beinart NA, Goodchild CE, Weinman JA, Ayis S, Godfrey EL. Individual and intervention-related factors associated with adherence to home exercise in chronic low back pain: a systematic review. Spine J 2013;13:1940–50.
[23] Friedrich M, Gittler G, Halberstadt Y, Cermak T, Heiller I. Combined exercise and motivation program: effect on the compliance and level of disability of patients with chronic low back pain: a randomized controlled trial. Arch Phys Med Rehabil 1998;79:475–87.
[24] Pillastrini P, Gardenghi I, Bonetti F, et al. An updated overview of clinical guidelines for chronic low back pain management in primary care. Joint Bone Spine 2012;79:176–85.
[25] Hurley DA, Tully MA, Lonsdale C, et al. Supervised walking in comparison with fitness training for chronic back pain in physiotherapy: results of the SWIFT single-blinded randomized controlled trial (ISRCTN17592092). Pain 2015;156:131–47.
[26] McDonough SM, Tully MA, Boyd A, et al. Pedometer-driven walking for chronic low back pain: a feasibility randomized controlled trial. Clin J Pain 2013;29:972–81.
[27] Wertli MM, Rasmussen-Barr E, Held U, Weiser S, Bachmann LM, Brunner F. Fear-avoidance beliefs-a moderator of treatment efficacy in patients with low back pain: a systematic review. Spine J 2014;14:2658–78.
[28] Dyrstad SM, Hansen BH, Holme IM, Anderssen SA. Comparison of self-reported versus accelerometer-measured physical activity. Med Sci Sports Exerc 2014;46:99–106.
[29] Lee J. An insight on the use of multiple logistic regression analysis to estimate association between risk factor and disease occurrence. Int J Epidemiol 1986;15:22–9.