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Research Article

Association between Physical Activity and Cognitive Dysfunction in the Korean: A Cross-sectional Study

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ABSTRACT

Objectives: This study aimed to investigate the association of physical activity and cognitive function in the Korean population.

Methods: This study included 9,177 adults aged 45 years and older who completed the baseline survey of the Korean Longitudinal Study of Ageing. Physical activity was assessed using a questionnaire. Cognitive function was assessed using the Mini Mental Status Evaluation.

Results: The odds ratio for the cognitive dysfunction was significantly and linearly decreased according to the levels of physical activity independent of confounding factors. We also found consistent results when investigated these associations using stratified model by sex and age groups.

Conclusions: Our findings suggest that physical activity is associated with lower risk of cognitive dysfunction in the middle-aged and older Korean adults.

INTRODUCTION

Dementia is a major health problem in the elderly with estimated 46.8 million people affected worldwide in 2015. The prevalence of dementia is also estimated to be close to 50 million people in 2017 and to double every 20 years, reaching 75 million in 2030 and 131.5 million in 2050 [1]. The cognitive functional decline is observed in most elderly people. Previous epidemiological studies suggested that cognitive decline is associated with development of dementia. Annually, 10–15% of older people with mild cognitive impairment progress to dementia compared with 1–2% of older people with normal cognition [2,3].

Previous studies suggests that higher physical activity are associated with prevention of the decline in cognitive function and reduced risk of dementia with aging [4-6]. In addition, changes in physical activity may contribute to age-related changes in biological vitality and physical function. Moreover, higher levels of physical activity is associated with a decreased risk of cardiovascular disease, all-cause and cardiovascular mortality, physical function decline, and frailty [7-10]. Therefore, physical activity may also have an effect on the risk of cognitive dysfunction.

Previous studies have investigated the association between physical activity and cognitive functions. However, only a few examined the associations between physical activity and cognitive function in the Korean population. Additionally, to our knowledge, physical activity level rec-

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ommended by current guidelines for Korean adults has not been reported as a potential predictor of cognitive dysfunction in the older Korean adults. Therefore, we aimed to investigate whether physical activity is associated with the risk of cognitive dysfunction in the elderly Korean population.

METHODS

Study Participants

The present study used the data from the Korean Longitudinal Study of Ageing (KLoSA), a national survey of adults aged ≥ 45 years [11]. The KLoSA was started in August 2006, and 10,254 subjects completed the baseline survey interview using computer-assisted personal interviewing method. In this study, we selected 4,165 participants aged ≥ 45 years, and 1,077 subjects were excluded due to missing data for physical activity, cognitive function score, and other covariates. For this analysis, a total of 9,177 subjects were included. All subjects provided written informed consent, and the study protocol was approved by the Institutional Review Board of the Korea Employment Information Service.

Assessment of Physical Activity

The total volume of physical activity was assessed using a questionnaire. All subjects were asked to record the frequency of physical activity (times per week) and duration (min). Time spent being physically active was calculated considering frequency and duration in minutes per week. The subjects were categorized into three groups by total physical activity time: inactive (none), < 150 min per week, and ≥ 150 min per week based on the current physical activity guidelines for Korean adults [7,12].

Cognitive Function

Cognitive function was assessed using the Korea-Mini Mental Status Evaluation (K-MMSE). The K-MMSE comprises five areas, including registration, orientation, memory, attention and calculation, and language [13,14]. We categorized subjects into normal cognitive (K-MMSE ≥ 24) and cognitive dysfunction (K-MMSE < 24) groups [15].

Confounding Factors

Age, sex, education level, smoking status, and medical health conditions (depression, hypertension, diabetes, cardiovascular disease, and cancer) were considered as potential confounders. We categorized education levels as < high school, high school, or > high school. Smoking status was defined as never, former smoking, and current smoking. Medical health conditions were assessed using self-reported questionnaire.

Statistical Analysis

We analyzed all dataset using SPSS software (PASW Statistics 18 for Windows, IBM Inc., Chicago, IL, USA), and the results were considered statistically significant with P-values < 0.05. The subjects' characteristics are expressed as mean ± standard deviation (SD) for continuous variables and sample size (%) for categorical variables. We analyzed the characteristics of study participants by physical activity levels using the ANOVA for continuous variables and Chi-squared tests for categorical variables. Multivariable logistic regression models were used to assess the association of physical activity levels and the risk of cognitive dysfunction. We also developed three sequential models to test the effect of confounding factors on the association between physical activity and cognitive dysfunction: 1) adjusted for age and sex; 2) additionally adjusted for education level and smoking status; 3) additionally adjusted for depression, hypertension, diabetes, cardiovascular disease, and cancer. In addition, we conducted sensitivity analysis using separated model by age group (< 65 years and ≥ 65 years) and sex.

RESULTS

In Table 1, characteristics of the participants are presented. The mean age was 61.04±10.91 years. Overall, 44.55% of participants were men, and 55.45% were women. The mean cognitive function sore was 24.56±5.93. Table 2 shows the characteristics of study participants by physical activity level. We found significant differences in age, cognitive function score, and prevalence of cognitive dysfunction (all P<0.001, Table 2).

Table 3 shows the results of multivariable odds ratio (OR) and 95% confidence interval (CIs) for the risk of cognitive dysfunction by physical activity levels. Levels of physical activity were significantly associated with a reduced risk of cognitive dysfunction after adjustment for age and sex. The results were not changed after additionally adjusted for education level and smoking status. In fully adjusted model, we also found significant association between physical activity levels and cognitive dysfunction (Table 3, model 3). We also found consistent results when investigated these associations using stratified model according to sex and age group (Table 4).

DISCUSSION

In this study, we investigated the association between physical activity levels and the risk of cognitive dysfunction in the Korean population. Our findings suggest that higher level of physical activity is significantly associated with a lower risk of cognitive dysfunction independent of clinical health conditions and other potential confounding factors. Moreover, sensitivity analysis using stratified model by age group and sex also showed similar association between higher levels of physical activity and decreased risk of cognitive dysfunction. These findings suggest that low physical activity may be a risk factor for cognitive function decline in the general Korean population.

In the present study, the prevalence of cognitive dysfunction was approximately two times higher in participants with the lowest levels of physical activity compared to those with the highest physical activity levels. The present study is the first investigation that confirmed the association of physical

Table 1. Characteristics of study participants

Characteristics	Distribution	
Age (years)	61.04	±10.91
Body mass index (kg/m^2)	23.48	±7.61
Cognitive function (K-MMSE, score)	24.56	±5.93
Sex (%)		
Male	4088	(44.55)
Female	5089	(55.45)
Education level (%)		
<high school	5636	(61.41)
high school	2513	(27.38)
>high school	1028	(11.20)
Smoking status (%)		
Never	6486	(70.68)
Former smoker	889	(9.69)
Current smoker	1802	(19.64)
Depression (%)		
No	8126	(88.5)
Yes	1051	(11.5)
Hypertension (%)		
No	6732	(73.36)
Yes	2445	(26.64)
Diabetes (%)		
No	8105	(88.32)
Yes	1072	(11.68)
CVD (%)		
No	8749	(95.34)
Yes	428	(4.66)
Cancer (%)		
No	8958	(97.61)
Yes	219	(2.39)

Data are means ± SD for continuous variables and sample size (%) for categorical variables.

activity and cognitive dysfunction in the middle-aged and older Korean populations. The results of our study are consistent with previous reports showing that physical activity is associated with risk of cognitive dysfunction and mild cognitive impairment [16-19]. For example, a study on the community-dwelling older adults reported that daily physical activity was associated with cognitive function variability in the elderly [20]. In addition, 28-year follow-up study analyzed using Whitehall II cohort reported that lower levels of physical activity was associated with an increased risk of dementia in the elderly [21].

Biological ageing contributes to the changes in nervous system function, which could explain the association of physical activity and cognitive decline during aging process [22]. A decline in the function of the central nervous system with aging may be an important mechanism underlying the association of physical activity and cognitive dysfunction. In fact, a slow reaction is associated with decreased cognitive function in the older adults [23]. Moreover, another systematic review and meta-analysis reported a longitudinal association of physical activity and changes in cognitive abilities [19]. Thus, physical activity might contribute to prevention of age-related decrease in the central nervous system function, which is reflected in cognitive dysfunction.

Previous epidemiological studies have described the association between physical activity and cognitive dysfunction. Our results are consistent with several recent studies, in which physical activity was associated with a risk of cognitive dysfunction in the older population. However, there remains a lack of information about the effect of physical activity on the risk of cognitive dysfunction in the middle-aged population. Therefore, in this study, we also investigated the association of physical activity levels and the risk for cognitive dysfunction using stratified model, and we observed no difference between the middle-aged and older populations. These findings suggest that physically active lifestyle may prevent cognitive decline with ageing even in middle-aged adults. However, further longitudinal and intervention studies are necessary.

Table 2. **Characteristics of study participants by physical activity levels**

Characteristics	High (n=2552)		Low (n=1002)		Inactive (n=5623)		P-value
Age (years)	59.51	±0.21	58.47	±0.34	62.19	±0.14	<0.001
Cognitive function (K-MMSE, score)	25.93	±0.12	26.11	±0.18	23.67	±0.08	<0.001
Cognitive dysfunction							
No	2126	(83.31)	852	(85.03)	3722	(66.19)	<0.001
Yes	426	(16.69)	150	(14.97)	1901	(33.81)	
Sex (%)							
Male	1244	(48.75)	479	(47.80)	2365	(42.06)	<0.001
Female	1308	(51.25)	523	(52.20)	3258	(57.94)	
Education level (%)							
<high school	1215	(47.61)	480	(47.90)	3941	(70.09)	<0.001
high school	856	(33.54)	353	(35.23)	1304	(23.19)	
>high school	481	(18.85)	169	(16.87)	378	(6.72)	
Smoking status (%)							
Never	1816	(71.16)	695	(69.36)	3975	(70.69)	<0.001
Former smoker	329	(12.89)	123	(12.28)	437	(7.77)	
Current smoker	407	(15.95)	184	(18.36)	1211	(21.54)	
Depression (%)							
No	2292	(89.81)	888	(88.62)	4946	(87.96)	0.051
Yes	260	(10.19)	114	(11.38)	677	(12.04)	
Hypertension (%)							
No	1845	(72.30)	750	(74.85)	4137	(73.57)	0.253
Yes	707	(27.70)	252	(25.15)	1486	(26.43)	
Diabetes (%)							
No	2222	(87.07)	878	(87.62)	5005	(89.01)	0.031
Yes	330	(12.93)	124	(12.38)	618	(10.99)	
CVD (%)							
No	2420	(94.83)	957	(95.51)	5372	(95.54)	0.357
Yes	132	(5.17)	45	(4.49)	251	(4.46)	
Cancer (%)							
No	2481	(97.22)	977	(97.50)	5500	(97.81)	0.256
Yes	71	(2.78)	25	(2.50)	123	(2.19)	

Data are means ± SD for continuous variables and sample size (%) for categorical variables.
P-values were calculated using the ANOVA for continuous variables and Chi-squared test for categorical variables.

Table 3. **Multivariable OR (95% CI) for the risk of cognitive dysfunction by physical activity levels**

	Model 1	Model 2	Model 3
Physical activity	OR (95% CI)	OR (95% CI)	OR (95% CI)
Inactive (n=5623)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Low (n=1002)	0.48 (0.43-0.55)	0.56 (0.49-0.64)	0.55 (0.48-0.63)
High (n=2552)	0.44 (0.36-0.54)	0.50 (0.41-0.62)	0.49 (0.40-0.60)
P-for trend	<0.001	<0.001	<0.001

Model 1: adjusted for age and sex.
Model 2: adjusted for age, sex, education level, and smoking status.
Model 3: adjusted for age, sex, education level, smoking status, depression, hypertension, diabetes, cardiovascular disease, and cancer.

Table 4. Multivariable OR (95% CI) for the risk of cognitive dysfunction by physical activity levels according to participants characteristics

Physical activity	N	OR (95% CI)	N	OR (95% CI)
		Male		Female
Inactive	2365	1.00 (reference)	3258	1.00 (reference)
Low	479	0.56 (0.45-0.69)	523	0.56 (0.47-0.67)
High	1244	0.54 (0.39-0.74)	1308	0.47 (0.36-0.61)
P-for trend		<0.001		<0.001
		<65 years		≥65 years
Inactive	3248	1.00 (reference)	2375	1.00 (reference)
Low	721	0.69 (0.57-0.83)	281	0.47 (0.39-0.57)
High	1735	0.55 (0.41-0.74)	817	0.44 (0.33-0.59)
P-for trend		<0.001		<0.001

Models defined in Table 3 (Model 3) were used.

Strengths and Limitations

Several limitations of this study should be acknowledged. In the present study, the primary limitation is that we cannot infer causal effect of physical activity on the risk of cognitive dysfunction because of the cross-sectional design. Moreover, we assessed the total volume of physical activity but not each type, such as intensity and domain specific activity parameters, that may predict cognitive decline [24-26]. However, our study included a large nationally representative sample of Korean adults, and our analyses were considered for important confounding factors. Thus, our findings can be generalized to the Korean population. However, the level of physical activity in Koreans is still insufficient, and the amount of physical activity has been decreasing during the past decade [27]. Recently, a systematic review showed that physical activity intervention may help to improve cognitive function in the middle-aged adults [28-30]. Therefore, our findings of this study are important for public health strategies aimed at preventing cognitive dysfunction in the Korean population.

CONCLUSIONS

We found that higher physical activity was strongly associated with decreased risk of cognitive dysfunction in Korean adults. Further study of the prospective association of physical activity and the risk of new onset cognitive dysfunction is warranted.

Conflicts of interest

The authors declare no conflicts of interest.

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