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Effect of Aerobic Exercise on Cognitive Function in the Elderly persons

The Goal of this study was to assess the effect of aerobic exercise on cognitive function of elderly people. The participants' cognitive functions were measured before exercise. Exercise was practiced three times a week for nine weeks. The aerobic exercises consisted of warm-up exercises for five minutes followed by cycling for 30 minutes. The exercise intensity was set to 65%~75% of the intensity for the maximum heart rate(220-age). The control group did not perform any exercises. The subjects' cognitive functions were measured nine weeks later. In the aerobic exercise group, between before and after the exercises, significant increases appeared in total K-MMSE scores and scores of some sub items comprising memory registration, concentration and calculation abilities but not in other items. In the control group, no significant differences appeared in any items between before and after the experiment. In a comparison between the aerobic exercise group and the control group, significant differences appeared in total K-MMSE scores and scores of two sub items comprising concentration and calculation abilities but not in other items($p<.05$). Aerobic exercises were effective in the improvement of cognitive functions and among sub items of cognitive functions, concentration and calculating abilities were improved. Aerobic exercises performed by elderly persons are considered to be effective in improving cognitive functions.

Key words: *Aerobic Exercise; Cognitive Function; Cycle Exercise; Lower Extremities Activity; Elderly*

Ja Pung Koo[a], Ok Kon Moon[b]

[a]Pohang University, Pohang; [b]Kunjang University College, Gunsan, Korea

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Address for correspondence
Ok Kon Moon, PT, Ph.D
Department of Physical Therapy, Kunjang University College, Doam-ri, Seongsan-myeon, Gunsan-si, Jeolla buk-do, Korea
Tel: 82-63-450-8388
E-mail: ogmoon@kunjang.ac.kr

INTRODUCTION

Korea has been showing the highest aging speed in the world. Korea has already become an aging society in terms of the ratio of elderly populations aged 65 years or older and is expected to become a super-aged society where elderly populations account for 20% or more of entire populations by 2027(1). Along with this increase in elderly populations, the number of patients with senile disease of today increased by 205.7% compared to 2002 from 499,000 to 1,027,000 and the total amount of medical bills has been showing a sharply increasing tendency with an increase by 419.5% from 581.3 billion won to 2 trillion and 438.7 billion won(2).

In the case of those with mild cognitive disorders, low perfusion appears in the left putamen, globus pallidus, left insula, left posterior cingulate gyrus, right parahyppocampal gyrus and cuneus, etc.(3). Whereas decreased perfusion in local cerebral regions becomes a cause of declined cognitive functions as such, increases in cerebral perfusion through exercise can improve cognitive functions(4). Exercise-enhanced neuronal plasticity might help neural circuits spared, or less affected by a disease to compensate for deteriorated circuits and improve other network performance and overall neurological function(5). Exercise has been shown to appear responsible for significant improvement in learning and memory performance(6). Therefore, exercise is presented as an effective method to improve brain functions(7). In a phone questionnaire survey study based on the mini mental state examination(MMSE) Jennifer et al. reported that changes in cognitive function states of 18,766 subjects were followed up for seven years and according to the results, high levels of physical activities including walking for long periods of time were effective in reducing declines in cognitive functions in female elderly persons(8).

In elderly persons, exercise has diverse positive effects(9, 10), and in particular, prevents physical strength reduction and decreases in functional abilities(11, 12, 13). It has been said that in elderly persons, physical activities help maintaining cognitive functions and as evidence for this, it has been reported that when healthy elderly persons performed aerobic exercises, their cardiopulmonary functions improved and cognitive functions such as motor skills, cognitive speeds, delayed recall functions, and visual attention were favorably affected(14). Although study results indicating that exercise brings about positive effects on many cognitive areas, since few studies have been conducted on the effects of exercise interventions on elderly persons' cognitive functions thus far, the results cannot be safely generalized. In this respect, this researcher intends to examine the effects of aerobic exercises using fixed cycles on elderly persons' cognitive functions in order to help the preparation of exercise programs necessary for elderly persons' cognitive functions.

METHODS

Subjects

The present study was conducted from June 11, 2011 to August 3, 2011 at two senior citizen's centers located in Yeongdeok-gun, Gyeongbuk with 16 elderly persons who were able to participate in exercise programs and agreed to the present study. General characteristics of the subjects are as follows(Table 1).

Table 1. General characteristics of the subjects

	AEG(n=8)	CG(n=8)	Total	P
Sex(mal/female)	3/5	3/5	6/10	
Age(yr)	[a]71.38±5.78	72.63±3.58	72.00±4.690	.611
Hight(cm)	161.00±6.23	159.38±7.43	160.19±6.68	.643
Weight(kg)	56.50±7.78	51.25±5.68	53.88±7.12	.145
MMSE-K(total score)	24.12±1.96	24.38±.92	24.25±1.48	.870

AEG : aerobic exercise group, CG : control group
[a]M±SD : mean±standard deviation

Procedure

The participants' cognitive functions were measured before exercise. Exercise were practiced three times a week for nine weeks. The aerobic exercises consisted of warm-up exercises for five minutes followed by cycling for 30 minutes. The exercise intensity was set to 65%~75% of the intensity for the maximum heart rate(220-age). The control group did not perform any exercises. The subjects' cognitive functions were measured nine weeks later.

Measurement

Cognitive functions were tested using the Korean version of mini mental state exam(K-MMSE). The K-MMSE was made from the mini-mental state exam(MMSE) developed by Folstein et al. with revisions and supplementation by Park and Gwon. It is set to have a full score of 30 points for 12 questions in areas as follows; orientation, registration, recall, attention and calculation, language and visuospatial(15, 16)

Data Analysis

In the present study, the statistical program SPSS 18.0 was used for data analysis. General characteristics of the study subjects were produced as frequency analysis, means and standard deviations. Wilcoxon signed-ranks tests were conducted to examine changes in the elderly persons' cognitive functions between before and after the exercises and Mann-Whitney tests were conducted to examine differences in changes between the groups. To test statistical significance, the significance level was set to $\alpha = .05$.

RESULTS

Comparison of Cognitive Functions Resulted from Exercises

In the aerobic exercise group, between before and after the exercises, significant increases appeared in total K-MMSE scores and scores of some sub items comprising memory registration, concentration and calculation abilities but not in other items. In the control group, no significant differences(differences) appeared in any items between before and after the experiment.

In a comparison between the aerobic exercise group and the control group, significant differences appeared in total K-MMSE scores and scores of two sub items comprising concentration and calculation abilities but not in other items($p<.05$)(Table 4).

Table 4. Comparison of cognitive functions according to exercises

(unit : point)

K-MMSE	Group	Pre test (mean±S.D.)	Post test (mean±S.D.)	Post-pre (mean±S.D.)	Z	p	D-value	
							Z	p
Orientation	AEG	8.50±.76	9.00±.00	.50±.76	-1.633	.102	-1.852	.064
	CG	9.00±.00	9.00±.00	.00±.00	.000	1.000		
Registration	AEG	2.25±.46	2.88±.35	.63±.52	-2.236	.025*	-1.273	.203
	CG	2.50±.54	2.63±.52	.13±.84	-.447	.655		
Attention and calculation	AEG	2.50±.54	3.00±.54	.50±.54	-2.000	.046*	-2.324	.020*
	CG	2.63±.52	2.50±.54	-.13±.36	-1.000	.317		
Recall	AEG	2.50±.54	2.88±.35	.38±.52	-1.732	.083	-1.356	.175
	CG	2.25±.46	2.25±.46	.00±.54	.000	1.000		
Language and visuospatial	AEG	8.50±.76	8.75±.46	.25±.71	-1.000	.317	-1.369	.171
	CG	8.00±.00	7.88±.35	-.13±.35	-1.000	.317		
Total	AEG	24.13±1.96	26.63±1.19	2.50±2.14	-2.410	.016*	-2.576	.010*
	CG	24.38±.92	24.25±1.17	-.13±1.46	-.322	.748		

*p<.05
AEG: aerobic exercise group
CG: control group

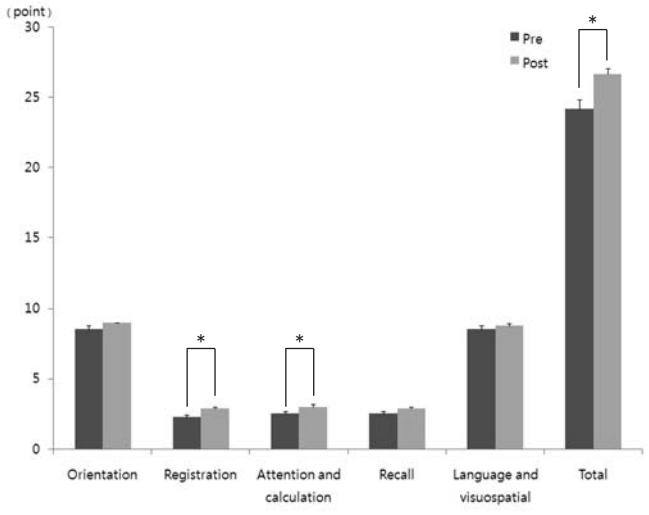

Fig. 1. Changes in cognitive functions resulted from aerobic exercises

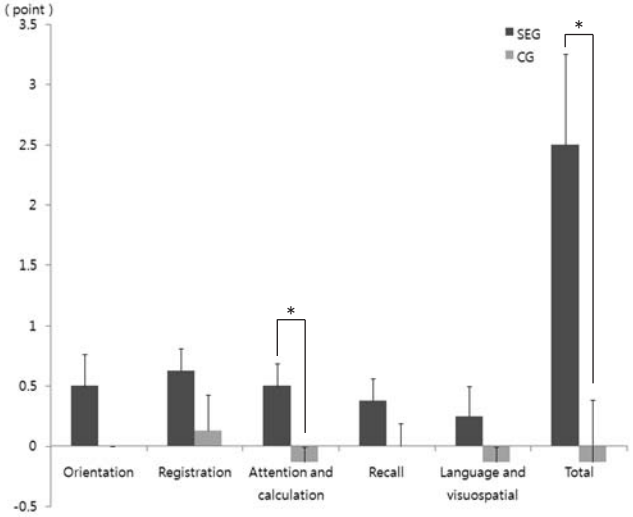

Fig. 2. Comparison of changes in cognitive function between group

DISCUSSION

In the present study, aerobic exercises using fixed cycles for nine weeks applied to elderly persons improved the elderly persons' cognitive functions. These results can be reference data for exercise methods for improving elderly persons' cognitive functions and will be helpful in preventing declines in elderly persons' cognitive functions.

In the present study, based on the results of many previous studies indicating that exercise and physical activities positively affects elderly persons, the effects of aerobic exercises using cycles on elderly persons' cognitive functions were examined(8, 9, 10, 11, 12). It has been said that in senescence, cognitive functions rapidly decrease as ages increase and that whereas the atrophy of the frontal lobe and the prefrontal lobe is a prominent characteristics of brain function declines in the process of aging, exercise activates the functions of the frontal lobe, in particular, the prefrontal lobe and the hippocampus(17). For this reason, exercise is presented as an effective method to improve brain functions(7).

There are reports indicating that exercises performed by elderly persons with damage to cognitive functions had positive effects on the improvement of cognitive functions(17, 18, 19). Yaffee et al. insisted that regular exercise that focuses on functional fitness, such as walking, has been associated with significant reductions in the levels of dependence and disability in older adults(20, 21).

Colcombe et al. insisted that aerobic fitness training appears to have an association with reduced brain tissue loss in aging humans(22). Patrica et al. insisted that exercise increases cognitive function in people with dementia and related cognitive impairments(23). In a study conducted by Geda et al., it was reported that although mild exercises and strenuous exercises were not clearly associated with the relief of mild cognitive disorders, moderate exercises such as machine cycles which are aerobic exercises were effective in reducing the risk of mild cognitive disorders in elderly persons who performed these exercises 5–6 times a week(24). Previous studies on the association between cognitive functions and exercise reported that elderly persons who performed walking exercises frequently at normal times were less likely to have declined cognitive functions compared to elderly persons who did not perform exercises(21) and that aerobic exercises were highly correlated with cognitive functions(25). Regular aerobic exercises improve elderly persons' cognitive information processing speeds and neuromuscular coordination(26). Kim reported that memory, abilities to solve problems and abilities to infer were shown to be higher after performing regular exercises in both male and female elderly persons(27). Gwak and Eom reported that when 30 dementia patients performed exercise for 30~60 minutes per time, 2~3 times per week for 12 months, cognitive functions were improved in the exercise group(28). Results of the present study correspond with the results of earlier studies which reported that aerobic exercise can be improved cognitive function.

Tradmill training and physical training was no improvement in MMSE(29). Results of the present study are in contrast to the results of Son(29).

CONCLUSION

To examine the effects of aerobic exercises on elderly persons' cognitive functions, aerobic exercises using cycles were implemented for nine weeks. Aerobic exercises were effective in the improvement of cognitive functions and among sub items of cognitive functions, concentration and calculating abilities were improved. Aerobic exercises performed by elderly persons are considered to be effective in improving cognitive functions. Aerobic exercises should be recommended for the improvement of elderly persons' cognitive functions.

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