Effects of long-term multi-task exercise program on blood pressure, physical function and cognitive function in mild cognitive impairment elderly women with hypertension

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

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Abstract

Background and Study Aim: Considering the elderly quality of life (QOL), cognitive functions including memory, flashback, language as well as physical health are highly important. The aim of study is the relationship between blood pressure and cognitive function and physical function through random comparison tests by developing a multi-task exercise program including simple and moderate exercise and cognitive training that can be practiced on a regular basis to the mild cognitive impairment (MCI).

Material and Methods: Twenty subjects with MCI-diagnosed hypertensive elderly women in this study and were randomly divided into one of two groups: multi-task exercise group (n = 10) and control group (n = 10). The multi-task exercise program was conducted in program for 90 minutes, two times a week for 24 weeks. Health care education program was conducted by a specialist once in a two weeks and body composition check and personal consultation were done in every other week.

Results: Body weight (p<.05) and Body Mass Index (p<.05) showed a valid difference in the interaction between the group and time. In addition, there was a valid difference in the interaction between the group and time in moderate to vigorous physical activity (p<.05), step count (p<.05), short physical performance battery (p<.05), One legged standing time (p<.01), 6-minute walking (p<.05). Moreover, a valid difference in the interaction between the group and time was shown in Korean version of Geriatric Depression Scale-short form (p<.05), Korean version of Mini Mental State Examination (p<.05) and Korean version of Montreal Cognitive Assessment (p<.05).

Conclusions: The multi-task exercise program has a positive impact on improving the body composition, physical function, blood pressure and cognitive function. In particular, maintaining the long-term regular physical activity is a critical factor for preventing the decline in cognitive function.

Keywords: body composition • depression assessment • global cognition assessment • kinematic intervention

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Hypertension – *noun* arterial blood pressure that is higher than the usual range for gender and age. Also called **high blood pressure**, **hyperpiesia**. Compare **hypotension** [47].

Physical activity – *noun* exercise and general movement that a person carries out as part of their day [47].

Exercise program – *noun* same as **fitness program** [47].

Cognitive – *adjective* relating to the process of acquiring knowledge by the use of reasoning, intuition or perception [47].

Appendicular – *adjective* referring to body parts which are associated with the arms and legs [47].

Kinematics – *noun* the scientific study of motion [47].

MET – *abbreviation* metabolic equivalent [47].

Metabolic equivalent – *noun* a unit used for expressing the resting metabolic rate. Abbreviation **MET** [47].

INTRODUCTION

Considering the elderly quality of life (QOL), cognitive functions including memory, flashback, language as well as physical health are highly important. In tandem with an increase in elderly population, Alzheimer's dementia rate is increasing rapidly [1], and it is reported that the number of patients with dementia will be increased to 82 million by 2030 and be tripled to 135 million by 2050 [2]. In addition, dementia shows higher prevalence in female than in male, and the reason is reported to be a longer life span of female as well as a decline in female hormone, which is one of the dementia factors [3].

The decline in elderly's cognitive function is a detrimental factor for healthy span and QOL; if one has a hypertension, an inelasticity of blood vessel can cause resistance in cerebrovascular and reduction in cerebral blood flow (CBF), which is known to raise the possibility of incurring dementia [4, 5]. Especially for the elderly, the rise in blood pressure changes brain structure and function, and ultimately incurs reduction in cognitive function [6]. For these reasons, the hypertensive elderly are fragile to sustain stable cognitive function.

Although there are some pharmacological treatment methods for dementia, it is hard to delay the progress or to recover fully [7], and it also accompanies high cost. Thus, as a measure to prevent dementia, the effort to non-pharmacological treatments is considered to play an important role in preventing or delaying dementia [8, 9].

As the interventions to prevent dementia with the non-pharmacological treatments to prevent dementia, regular physical activity [10, 11], social network, intellectual activity, participating in production activities [12-14], music, and art therapy [15] are recognized as preventive factors to dementia. However, while these interventions can be effective in cognitive function, the long-term application can expose them to sedentary life – in other words, it can cause some negative effects such as a lack of physical activity; thus kinematic intervention is thought to be an effective measurement to cognitive function of the hypertensive elderly [16, 17].

Meanwhile, the mild cognitive impairment (MCI) which is a state of a fall in mild cognitive function has been receiving an attention as a prior-stage of preventing dementia [18]. Referring to a transitional phase between the fall in cognitive function and early dementia induced by normal aging process [19, 20], the MCI shows a state of a rapid decline in memory while there is no reduction in an overall intellectual ability unlike early dementia, with the Active Daily Living (ADL) maintained stable [21, 22]. Thus, the early intervention in the MCI can be deduced to be highly important to prevent dementia.

In many research, the kinematic intervention has been emphasized to prevent and improve the MCI and dementia [23, 24]; however, a recent meta-analysis on the MCI has reported that the results of a single exercise have ambiguous effectiveness in treating the risks of the MCI and dementia [25], which contradicted the foregone studies. Moreover, when only physical activities were applied, the cognitive function showed little difference in large-scale longitudinal study compared to education groups [26] In order to tackle this problem, a multi-application of cognitive and exercise intervention has been suggested [27, 28].

Therefore, the aim of study is the relationship between blood pressure and cognitive function and physical function through random comparison tests by developing a multi-task exercise program including simple and moderate exercise and cognitive training that can be practiced on a regular basis to the MCI.

MATERIAL AND METHODS

Subjects

Having the MCI-diagnosed hypertensive elderly women explained about the aims and methods of the study both in writing and orally, the study was conducted 24 voluntary participants who agreed to a written consent. The study was approved by the Ethics Committee of Dong-A University (2-104709-AB-N-01-201712-HR-058-02). According to random assignment, the subjects were divided into a multi-task exercise group (n = 12) and a control group (n = 12). Four of them were excluded from the study for personal reasons. The final study sample comprised a multi-task group and a control group (n = 10 each), 20 subjects in total (Figure 1). The participants' physical characteristics are shown in (Table 1).

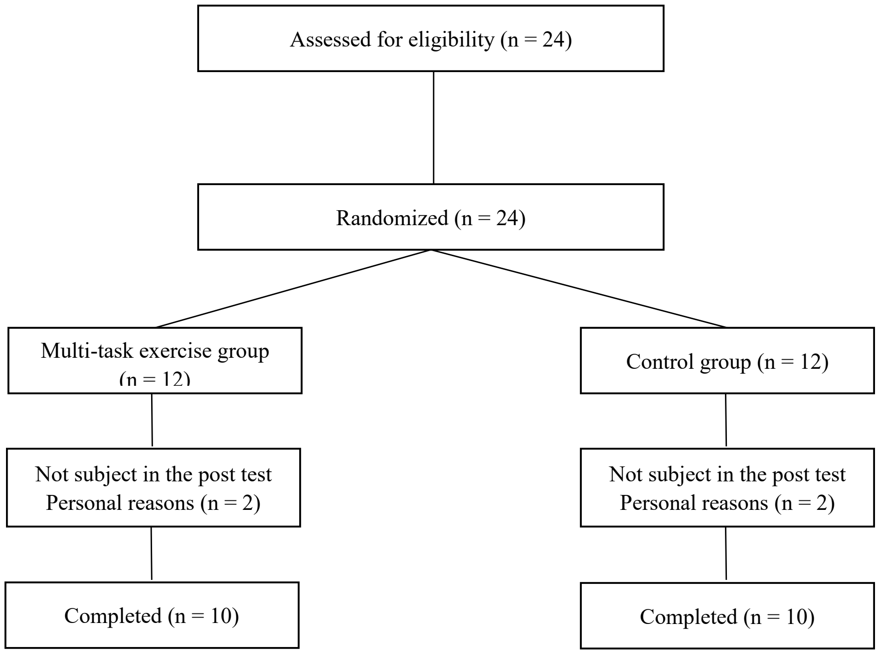

Figure 1. Flow diagram of subjects.

OUTCOME MEASURES

Body composition and blood pressure

The subjects were instructed to maintain fastened for eight hours and to attire comfortably. The measurement points were before and after the multi-task exercise. Body height, body weight, % body fat, fat mass, lean body mass (LBM), and appendicular skeletal muscle mass (ASM) were measured using the N20 (N20, AIIA Communication Inc., Korea).

Body Mass Index (BMI) was yield by weight/height (kg/m^2) formula, and appendicular skeletal muscle mass index (ASMI) was calculated with ASMI/height (kg/m^2) formula. Tapeline (Martine's body measuring instrument) was used to measure waist and hip circumference, and waist hip ratio (WHR) was calculated with waist/hip ratio formula. The blood pressure was measured two times (both systolic and diastolic), using a CK-E301 mercury blood pressure monitor (Chin Kou Medical Instrument Co., Ltd., Taiwan).

Physical activity measurement

Physical activities were measured using the Lifecoder (Kenz lifecoder, Tokyo, Japan). An accelerometer's activity intensity level (i.e., 11 level: 0, 0.5, 1~9; 0 is low activity, 9 is high activity) was measured in every 4 second, and the metrics of physical activity measured intensity (metabolic equivalents: METs) and daily step count (step/day) [29] of physical activity (moderate to vigorous physical activity: MVPA) from moderate-intensity (moderate-intensity effort 3-6 METs) to high-intensity (high-intensity effort >6 METS) except for low-intensity (low-intensity effort <3 METs).

Physical function measurement

As a combination of balance tests, chair stand test, and gate speed test among well-known elderly physical function assessments, a tool developed by Established Population for Epidemiologic Studies of Elderly (EPESE) – a multi-organization research held by National Institute of Aging (NIA) of the U.S. – Short Physical Performance Battery (SPPB) is composed of 0 point to 4 point, 12 point in total, in each criteria [30]. For grip strength, a digital dynamometer (Grip-D TKK5101, Japan) was used to measure the dominant hand twice and recorded the better results in 0.1kg units. For Time up & Go (TUG), the turnaround time was measured that required for the subjects to walk toward a cone located 2.44 m apart from the start line where the subjects sat still, and to come back to sit on a chair. Open-eyes one-legged standing time was measured from the moment the subjects raised their one leg to the moment they put it back to the ground with their one foot attached to calve and open-eyed. If the

Table 1. Baseline characteristics of socio-demographic, physical characteristic, blood pressure, daily physical activity, mental and cognitive function (means and standard deviation).

Variable	Exercise group (n=10)	Control group (n=10)	p-value
Age (years)	71.67 ±5.66	71.00±5.36	0.801
Educational level (years)	7.00 ±3.16	7.22±2.28	0.866
Body height (cm)	152.49 ±6.12	152.93±4.83	0.866
Body weight (kg)	55.63 ±5.78	54.73±4.43	0.716
Body mass index (kg/m^2)	23.82 ±1.23	23.36±1.74	0.527
Lean body mass (kg)	35.03 ±8.22	36.26±4.60	0.702
ASMI appendicular skeletal muscle mass index (kg)	6.16 ±1.07	6.18±0.64	0.979
Waist hip ratio	0.86 ±0.05	0.88 ±0.04	0.620
SBP systolic blood pressure (mmHg)	139.33 ±6.44	140.00 ±7.42	0.841
DBP diastolic blood pressure (mmHg)	79.44 ±12.18	78.44 ±12.82	0.867
MVPA moderate to vigorous physical activity (min/day)	19.76 ±12.33	16.95 ±13.87	0.657
Step count (step/day)	7485 ±3173	6408 ±3328	0.493
SGDS-K Korean version of Geriatric Depression Scale-short form (score)	6.67 ±3.54	5.56 ±3.00	0.483
K-MMSE Korean version of Mini Mental State Examination, (score)	25.44 ±1.51	24.89 ±2.57	0.584
MoCA-K Korean version of Montreal Cognitive Assessment (score)	21.00±4.27	20.00 ±2.87	0.568

subjects' leg touched the grounds or the other leg, the time counted the right before, and the subjects rested for a minute for the second trial; the better records were reported.

6-minute walking test was conducted to walk straight 20 m back and forth, as many times as they can within 6 minutes, having them self-regulate the speed and break time. Using G-sensor (BTS BIO ENGINEERING Corp, ITALY), Gait speed test utilized the average of two normal gait speed trial in 7 m, with 4 m of acceleration zone and 1.5 m of deceleration zone.

Depression assessment

Developed by Yasevage et al. [31] and then translated into the Korean version of Geriatric Depression Screening Scale (GDS) by Cho et al. [32], Geriatric Depression Scale-shot form (SGDS-K) was used for the measurement. Having 15 questions in total, each question consists of 0~1 point and the higher scores mean a higher level of depression; 10 points is suggested to be an optimal clinical efficacy to determine depression.

Global cognition assessment

The Korean version of MMSE (K-MMSE), a translated version of Mini-Mental State Examination (MMSE) developed by Folstein et al. [33], was utilized Kang et al. [34] to make sure Korean elderly use it. K-MMSE can assess the changes in cognitive function with its repeating measures, and the better function records higher points. 30 point in total, it is composed of orientation-time (5 point), orientation-space (5 point), memory registration (5 point), attention function and calculation (5 point), memory recall (3 point), and language and space-time composition skills (9 point).

Comprehensive cognition assessment

MoCA-K (Korean version of Montreal Cognitive Assessment) translated by Lee et al. [35], the Korean version of MoCA (Montreal Cognitive Assessment) developed by Nasreddine et al. [36], was used for comprehensive cognition assessment. MoCA-K consists the examinations of visuospatial/executive (5 point), naming (3 point), attention (6 point), language (3 point), abstraction (2 point), delayed recall (5 point), and orientation (6 point), 30 point in total.

Interventions

The multi-task exercise program was conducted in program for 90 minutes, two times a week for 24 weeks. Before and after the exercise, stretching and walking were mainly conducted, and vital checks such as blood pressure were carried out

Table 2. Multi-task exercise program.

Item	1~6 week (HRR 40~50%)	7~12 week (HRR 45~55%)	13~24 week (HRR 50~60%)	Time (min)
	Contents			
Check	Check on individual's daily physical activity amount and health condition			10
Warm-up	Sitting on a chair stretching shuttle walking	Sitting on a floor Stretching. Walking while talking	Standing stretching. Walk while doing addition and subtraction or while doing word chain	15
Main exercise	Walk straight in line. Toe rock-paper-scissors Step box. Ladder. Thera-band (yellow, red)	Body rock-paper-scissors multi-task. Walk straight in line, multi-task step box, multi-task. Ladder. Thera-band (green)	Body rock-paper-scissors multi-task. Walk straight in line, multi-task. Step box, multi-task. Ladder. Thera-band (blue)	50
Cool-down	Sitting on a chair stretching	Sitting on a floor stretching	Standing stretching	5
Practicing time	Suggesting exercise method at home and habitual adjustment			10

between the main exercise (toe rock-paper-scissors, walk in line, thera-band exercise, step box, shuttle walking, ladder, body rock-paper-scissors and etc.) and break time. The multi-task included accomplishing other tasks (such as counting, speaking, word chain, clap and etc.) while they were doing exercise.

In order to increase the amount of physical activities beside the exercise program, the study provided an exercise program manual that can be done at home and confirmed the individuals' activity amounts to each subject to evaluate weekly physical activity by using an acceleration sensor. During physical exercise, the heart rate was measured by wearing the portable wireless heart rate meter POLAR RS-400™ (Polar Electro Co., Finland). The set-up for exercise intensity was 40~50% of heart rate reserve (HRR) in week 1~6, 45~55% in week 7~12, and 50~60% in week 13~24. Health care education program was conducted by a specialist once in a two weeks and body composition check and personal consultation were done in every other week. The multi-task exercise program and health care education program are shown in Table 2 and Table 3.

Statistical analysis

The similarities of the multidimensional exercise group and control groups were verified using SPSS 22.0 for Windows. The descriptive statistics of all variables were calculated as means and standard

Table 3. Health care education program.

Week	Health care education program (biweekly)	Week	Personal consultation (Tuesday/biweekly)
1	Importance of health care	2	Body composition inspection and management
3	Necessity of exercise	4	
5	Correct stretching methods	6	
7	Stretching methods at home	8	
9	Correct aerobic exercise to stay healthy	10	
11	Easy aerobic exercise at home	12	
13	Necessity and correct way of muscle exercise	14	
15	Easy muscle exercise at home	16	
17	Risks of sedentary activity	18	
19	Physical activity to reduce sedentary activity	20	
21	Necessity of combined exercise	22	
23	Self-management way after finishing exercise	24	

deviations. A two-way repeated ANOVA was calculated to determine group differences. Independent and paired t-tests were performed when the effects of group and time were statistically significant. Pearson's correlation coefficients were calculated to identify associations among variables and the statistical significance was set at 0.05.

RESULTS

Body composition

Body weight (p<.05) and BMI (p<.05) showed a valid difference in the interaction between the group and time (Table 4).

Daily physical activity and physical function

The changes in daily physical activity and physical function are shown in (Table 5). MVPA (*p*<.05), step count (*p*<.05), SPPB (*p*<.05) and one legged standing time (*p*<.05) presented a valid increase in multi-task exercise group. In addition, there was a valid difference in the interaction between the group and time in MVPA (*p*<.05), step count (*p*<.05), SPPB (*p*<.05), One legged standing time (*p*<.01), 6-minute walking (*p*<.05).

Blood pressure, depression and cognitive function

In the multi-task exercise group, SBP (p<.05) and DBP (p<.05) decreased validly and K-MMSE (p<.05) increased validly. Moreover, a valid difference in the interaction between the group and time was shown in SGDS-K (p<.05), MMSE-K (p<.05) and MoCA-K (p<.05) (Table 6).

Correlations

The correlations between K-MMSE and SBP, MoCA-K and MVPA, SGDS-K and % body fat, Step count and BMI are shown in Figure 2. K-MMSE and SBP (r = −.532, p<.05), and Step count and BM I (r = −.570, p<.05) presented a negative correlation while MoCA-K and MVPA (r = .487, p<.05), and SGDS-K and % body fat (r = .606, p<.01) showed a positive correlation. Panel A: r = −.532, p = .023; B: r = .487, p = .041; C: r = .606, p = .008; D: r = −.570, p =.014

DISCUSSION

Dementia incurs a reduction in physical activities followed by the decline in cognition and physical function [37], and the major cause of cognitive

Table 4. The changes of body composition and blood pressure between the groups at baseline and after 24 weeks (means and standard deviation).

Variable	Group	Baseline	24 weeks	% diff	p-value
Body weight (kg)	Exercise	55.63 ±5.78	51.82 ±5.21	−6.85*	0.035
	Control	54.73 ±4.43	55.90 ±5.87	2.14	
Body mass index (kg/m²)	Exercise	23.82 ±1.23	22.30 ±2.52	−6.38*	0.036
	Control	23.36 ±1.74	23.82 ±1.77	1.97	
Waist hip ratio	Exercise	0.86 ±0.05	0.81 ±0.04	−5.81	0.129
	Control	0.88 ±0.04	0.88 ±0.06	0.00	
% Body fat	Exercise	36.42 ±8.71	31.54 ±8.88	−13.40	0.074
	Control	32.40 ±6.38	35.23 ±6.41	8.74	
Lean body mass (kg)	Exercise	35.03 ±8.22	35.29 ±4.17	0.74	0.855
	Control	36.26 ±4.60	36.07 ±3.83	−0.52	
Muscle mass (kg)	Exercise	32.58 ±5.59	33.06 ±3.71	1.47	0.320
	Control	33.79 ±4.31	31.83 ±3.30	−5.80	
Lower limb muscle mass (kg)	Exercise	11.40 ±1.77	11.96 ±1.46	4.91	0.222
	Control	11.09 ±1.69	10.93 ±0.69	−1.44	
ASMI appendicular skeletal muscle mass index (kg/m²)	Exercise	6.16 ±1.07	6.42 ±0.96	4.22	0.150
	Control	6.18 ±0.64	6.09 ±0.52	−1.45	

*p<.05

Table 5. The changes of daily physical activity and physical function between the groups at baseline and after 24 weeks (means and standard deviation).

Variable	Group	baseline	24 weeks	% diff	p-value
MVPA moderate to vigorous physical activity (min/day)	Exercise	19.76 ±12.33	36.03 ±15.61	82.34*	0.049
	Control	16.95 ±13.87	16.22 ±9.48	−4.31	
Step count (steps/day)	Exercise	7485 ±3173	11412 ±3028	52.46*	0.027
	Control	6408 ±3328	5467 ±1315	−14.69	
SPPB short physical performance battery (score)	Exercise	8.56 ±2.07	9.67 ±1.50	12.97**	0.019
	Control	8.33 ±2.06	8.22 ±2.05	−1.32	
Grip strength (kg)	Exercise	18.17 ±2.99	18.29 ±3.32	0.66	0.889
	Control	16.56 ±2.73	16.95 ±2.23	2.36	
Timed up & go (sec)	Exercise	7.74 ±1.18	7.37 ±1.65	−4.78	0.251
	Control	8.02 ±1.40	8.45 ±1.91	5.36	
One legged standing time (sec)	Exercise	19.11 ±13.71	28.81 ±12.85	50.76*	0.004
	Control	14.89 ±11.46	9.65 ±5.30	−35.19	
6-minute walking (m)	Exercise	457.89 ±81.71	474.00 ±66.50	3.72*	0.029
	Control	483.56 ±57.11	477.89 ±52.48	−1.24	
Normal gait speed (m/sec)	Exercise	1.05 ±0.14	1.00 ±0.13	−4.76	0.475
	Control	0.87 ±0.15	0.88 ±0.16	1.15	

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

malfunction is reported to be a lack of physical activity, depression, and the increased population of the elderly [38]. One of the characteristics of the MCI is that one can go through physiological dependence due to the decline in cognitive function and physical activity [39], which accompanies a risk of physical injuries such as a hurt from a fall and fracture because of an error of judgement induced by the decline in cognitive function [40]. Meanwhile, physical activities and cognitive function exercises are reported to have a highly beneficial effect not only to the cognitive function of the dementia elderly but to the QOL arisen from the increased living functions [41]. As a result of the study, it presented a noticeable improvement in body weight and BMI between the prior-to multi-task exercise and post-24 weeks of the exercise.

Considering the precedent research that explained the intimate relationship between the cognitive function and body composition [42], it

Table 6. The changes of blood pressure, depression and cognitive function between the groups at baseline and after 24 weeks.

Variable	Group	baseline	24 weeks	% diff	p-value
Systolic blood pressure (mmHg)	Exercise	139.33 ±6.44	127.00 ±18.83	−8.85	0.075
	Control	140.00 ±7.42	140.11 ±16.77	0.08	
Diastolic blood pressure (mmHg)	Exercise	79.44 ±12.18	74.00 ±8.35	−6.85	0.201
	Control	78.44 ±12.82	80.44 ±15.80	2.54	
SGDS-K Korean version of Geriatric Depression Scale-short form (score)	Exercise	6.67 ±3.54	3.78 ±2.05	−43.33*	0.025
	Control	5.56 ±3.00	6.78 ±2.86	21.94	
K-MMSE Korean version of Mini Mental State Examination (score)	Exercise	25.44 ±1.51	26.22 ±0.97	3.07*	0.029
	Control	24.89 ±2.57	23.78 ±2.49	−4.46	
MoCA-K Korean version of Montreal Cognitive Assessment (score)	Exercise	21.00 ±4.27	22.89 ±3.22	9.00*	0.020
	Control	20.00 ±2.87	19.11 ±1.62	−4.45	

*p<.05

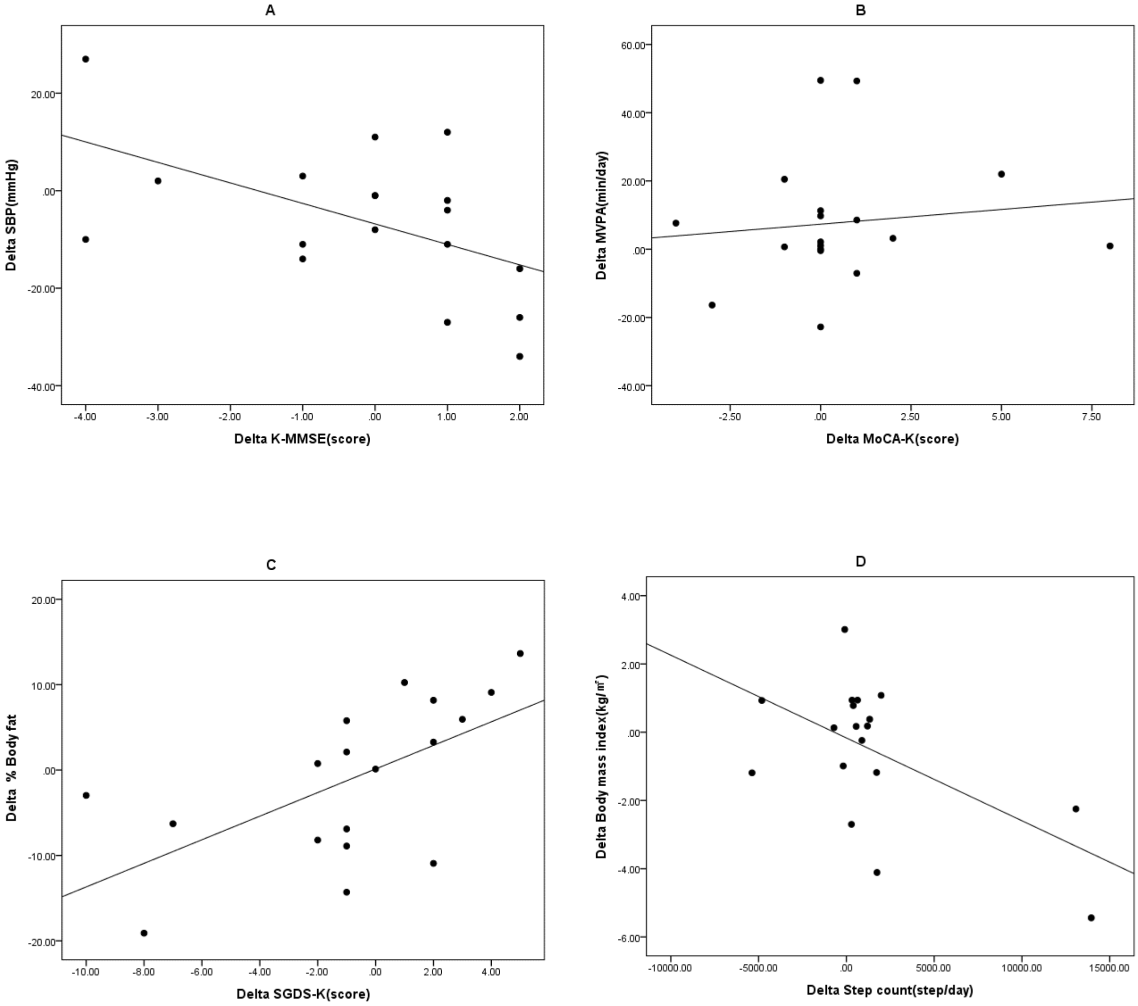

Figure 2. Correlation between cognitive function and SBP, MVPA and depression and % body fat and step count and BMI (n = 20)

Notes: **SBP**: systolic blood pressure, K**-MMSE**: Korean version of mini mental state examination, **MVPA:** moderate to vigorous physical activity, **MoCA**-K: Korean version of Montreal cognitive assessment, **SGDS**-K: Korean version of geri atric depression scale-short form.

is reasonable to think that improving body composition through multi-task exercise program can have a meaningful impact on improving cognitive function. In addition, there appeared a valid negative correlation between the BMI and step count, which means the increase in step count had have a positive effect on improving the BMI. On the changes in the daily physical activity amount and physical function, there were valid differences in interaction between the group and time in MVPA, step count, SPPB, One legged standing time and 6-minute walking. Moreover, the study showed a positive valid correlation between the MoCA-K and MVPA; concerning the valid correlation between the physical activity amount and cognitive function, the increase in physical activity is thought to be a meaningful result, and the overall increase in physical fitness is considered to have a positive impact on ADL and social activity of the elderly. In case of the gait speed, while there was no valid difference in the interaction between the group and time, there still were some improvements in the multi-task exercise group. Taking the preceding study into account that reported a close relationship among the gait speed, the survival rate of the elderly and the risks of physical injuries [40, 43], improving the gait speed through the increase in LBM and lower muscle mass is concerned to be an important factor. In addition, SBP and DBP have improved validly in the multi-task exercise.

As it is reported that the high blood pressure has a close relationship with the cognitive function [4, 5, 44], this study showed a valid negative correlation between the SBP and K-MMS. Thus, it can be said that improving blood pressure has a positive effect on the cognitive function of the high blood pressure elderly. The change in depression showed a valid difference in the interaction between SGDS-K and the group and time; and the daily physical activity (step count) and body composition (BMI), and body composition (% body fat) and SGDS respectively showed a valid correlation. Seeing the results of the study, the improvement in the physical activity amount has a positive impact on improving body composition, and ultimately to easing depression. Considering the report on the negative correlation between the physical activity amount and depression and positive correlation between the sedentary life and depression [45], and the study on effective depression prevention from exercises over the moderate-intensity and walking [46], the increase in physical activity amount is thought to be a meaningful result.

On the other hand, the change in the cognitive function showed a valid improvement in the interaction between the group and time in K-MMSE and MoCA-K. This showed a similar result with the report that presented a positive improvement on cognitive function of the elderly women by using multi-task cognitive function improvement program [28, 15]; especially, it can be acknowledge that conducting cognitive improvement program, including exercise intervention is effective in preventing dementia shown in the elderly. In this study, particularly, the SBP and MMSE-K showed a valid negative correlation and a positive correlation in MVPA and MoCA-K; this means improving body composition and the physical activity over the moderate-intensity has a positive impact on improving cognitive function. Concerning that the decline in cognitive function works as a critical factor for preventing dementia, the efficacy of the multi-task exercise program is a significant result. Thus, it can be said that the multi-task exercise program with the exercise and cognitive task can be much more beneficial and effective in improving cognitive function rather than a single bout exercise, and the further research needs to verify its effectiveness through a tracer study after the halt of the program.

Wrapping up the results above, the multi-task exercise program has a positive effect on improving physical function, blood pressure and depression, and especially the increase in physical activity is highly beneficial in cognitive function.

While this can be a meaningful result when considering the research improving cognitive function through the multi-task exercise program, it appears to be more significant in that practicing physical activity on a regular basis can prevent the decline in cognitive function.

CONCLUSIONS

The result showed that the multi-task exercise program has a positive impact on improving the body composition, physical function, blood pressure and cognitive function. In particular, maintaining the long-term regular physical activity is a critical factor for preventing the decline in cognitive function.

REFERENCES

1. Rocca WA, Petersen RC, Knopman DS et al. Trends in the Incidence and Prevalence of Alzheimer's Disease, Dementia, and Cognitive Impairment in the United States. Alzheimers Dement 2011; 7(1): 80-93
2. World Health Organization. Dementia. Geneva: World Health Organization. 2017 [cited 2018 Jun 18]. Available from: http://www.who.int/mediacentre/factsheets/fs362/en/
3. Jhoo JH, Kim KW, Huh Y et al. Prevalence of dementia and its subtypes in an elderly urban Korean population: results from the Korean Longitudinal Study on Health and Aging(KLoSHA). Dement Geriatr Cogn Disord 2008; 26(3); 270-276
4. de la Torre JC. Critically Attained Threshold of Cerebral Hypoperfusion: The CATCH Hypothesis of Alzheimer's Pathogenesis. Neurobiol Aging 2000; 21(2): 331-342
5. Kalaria RN. The Role of Cerebra Ischemia in Alzheimer's Disease. Neurobiol Aging 2000; 21(2): 321-330
6. Peters R. No clear relationship between antihypertensive class and cognitive function over 12 months in a cohort study of community-dwelling adults aged 80 and over. Ther Adv Chronic Dis 2019; 10; 2040622318820849
7. Sanford AM. Mild Cognitive Impairment. Clin Geriatr Med 2019; 33(3): 325-337
8. Gravitz L. Drugs: A tangled web of targets. Nature 2011; 475(7355): S9-S11
9. Petersen RC, Caracciolo B, Brayne C et al. Mild cognitive impairment: a concept in evolution. J Intern Med 2014; 275(3): 214-228
10. Laurin D, Verreault R, Lindsay J et al. Physical activity and risk of cognitive impairment and dementia in elderly persons. Arch Neurol 2001; 58(3): 498-504
11. Loprinzi PD, Joyner C. Accelerometer-determined physical activity and mortality in a national prospective cohort study: considerations by visual acuity. Prev Med 2016; 87: 18-21

12. Fratiglioni L, Wang HX, Ericsson K et al. Influence of social network on occurrence of dementia: a community-based longitudinal study. Lancet 2000; 355(9212): 1315-1319

13. Scarmeas N, Levy G, Tang MX et al. Influence of leisure activity on the incidence of Alzheimer's disease. Neurology 2001; 57(12): 2236-2242

14. Verghese J, Lipton RB, Katz MJ et al. Leisure activities and the risk of dementia in the elderly. N Engl J Med 2003; 348: 2508-2516

15. Lee MS, Song NH. The Effects of Cognitive Function Improvement Programs on the Cognitive Functions and Depression Indexes of Female Dementia Risk senior Groups. J Korean Assoc Phys Educ Sport Girls and Women 2016; 30(3): 253-268

16. Frith E, Loprinzi PD. Physical activity and cognitive function among older adults with hypertension. J Hypertens 2017; 35(6): 1271-1275

17. Sanders LMJ, Hortobágyi T, la Bastide-van Gemert S et al. Dose-response relationship between exercise and cognitive function in older adults with and without cognitive impairment: A systematic review and meta-analysis. PLoS One 2019; 14(1): e0210036

18. Dan S, Doris SFY. Effects of a Moderate-Intensity Aerobic Exercise Programme on the Cognitive Function and Quality of Life of Community-dwelling Elderly People with Mild Cognitive Impairment: A Randomised Controlled Trial. Int J Nurs Stud 2019; 93: 97-105

19. Perneczky R, Pohl C, Sorg C et al. Impairment of activities of daily living requiring memory or complex reasoning as part of the MCI syndrome. Int J Geriatr Psychiatry 2006; 21(2): 158-162

20. Boyle PA, Buchman AS, Wilson RS et al. Physical frailty is associated with incident mild cognitive impairment in community-based older persons. J Am Geriatr Soc 2010; 58(2): 248-255

21. Petersen RC, Smith GE, Waring SC et al. Mild cognitive impairment: Clinical characterization and outcome. Arch Neurol 1999; 56(3): 303-308

22. Petersen R, Doody R, Kurz A et al. Current concepts in mild cognitive impairment. Arch Neurol 2001; 58(12); 1985-1992

23. Yeon BH, Lee HJ. The Effect of Aquarobics Exercise on Alzheimer's Disease Dementia Factor and Cognitive Function in Elderly Women. Korea J Sports Sci 2017; 26(1): 983-991

24. Liu C, Herrmann N, Gallagher D et al. Designing a randomized, sham-controlled, parallel-design trial to investigate the effects of a combined exercise priming and transcranial direct current stimulation intervention in mild cognitive impairment and alzheimer's disease. Brain Stimul 2019; 12(2): 425

25. Gates N, Fiatarone SMA, Sachdev PS et al. The effect of exercise training on cognitive function in older adults with mild cognitive impairment: a meta-analysis of randomized controlled trials. Am J Geriatr Psychiatry 2013; 21(11): 1086-1097

26. Sink KM, Espeland MA, Castro CM et al. Effect of 24-Month Physical Activity Intervention vs Health Education on Cognitive Outcomes in Sedentary Older Adults The LIFE Randomized Trial. JAMA 2015; 314(8): 781-790

27. Alfini AJ, Weiss LR, Nielson KA. Resting Cerebral Blood Flow After Exercise Training in Mild Cognitive Impairment. J Alzheimers Dis 2019; 67(2); 671-684

28. Kim KH, Song NH. The Effect of the Complex Cognitive Enhancement Program on the Cognitive Functions, Depression Indexes, and the Dementia Risk Factors of Elderly Women. Korean J Phys Educ 2019; 58(1): 259-269

29. Aoyagi Y, Shephard YJ. Steps Per Day: The Road to Senior Health? Sports Med 2009; 39(6): 423-438

30. Guralnik JM, Ferrucci L, Simonsick EM et al. Lower-extremity performance in person over the age of 70 years as a predictor of subsequent disability. N Engl J Med 1995; 332(9): 556-561

31. Yesavage JA, Brink TL, Rose TL et al. Development and validation of a geriatric depression screening scale: A preliminary report. J Psychiatr Res 1983; 17(1): 37-49

32. Cho MJ, Bae JN, Suh GH et al. Validation of Geriatric Depression Scale, Korean Version(GDS) in the Assessment of DSM-III-R Major Depression. J Korean Neuropsychiatr Assoc 1999; 38(1): 48-63

33. Folstein MF, Folstein SE, McHugh PR. Mini-Mental-State: A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975; 12(3): 189-198

34. Kang Y, Na DL, Hahn S. A validity study on the Korean mini-mental state examination (K-MMSE) in dementia patients. J Korean Neurol Assoc 1997; 15(2): 300-308

35. Lee JY, Lee DW, Cho SJ et al. Brief screening for mild cognitive impairment in elderly outpatient clinic: validation of the Korean version of the Montreal Cognitive Assessment. J Geriatr Psychiatry Neurol 2008; 21(2): 104-110

36. Nasreddine ZS, Phillips NA, Bedirian V et al. The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. J Am Geriatr Soc 2005; 53(4): 695-699

37. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders. 5th edition (DSM-5). Arlington: American Psychiatric Association; 2013

38. Barnes DE, Alexopoulos GS, Lopez OL et al. Depressive symptoms, vascular disease, and mild cognitive impairment: findings from the Cardiovascular Health Study. Arch Gen Psychiatry 2006; 63(3): 273-279

39. Farias ST, Lau K, Harvey D et al. Early functional limitations in cognitively normal older adults predict diagnostic conversion to mild cognitive impairment. J Am Geriatr Soc 2017; 65(6): 1152-1158

40. Sungkarat S, Boripuntakul S, Chattipakorn N et al. Effects of tai chi on cognition and fall risk in older adults with mild cognitive impairment: a randomized controlled trial. J Am Geriatr Soc 2017; 65(4): 721-727

41. Coelho FGDM, Andrade LP, Pedroso RV et al. Multimodal exercise intervention improves frontal cognitive functions and gait in Alzheimer's diease: A controlled trail. Geriatr Gerontol Int 2013; 13(1): 198-203

42. Cronk BB, Johnson DK, Burns JM et al. Body mass index and cognitive decline in mild cognitive impairment. Alzheimer Dis Assoc Disord 2010; 24(2): 126-130

43. Studenski S, Perera S, Patel K et al. Gait Speed and Survival in Older Adults. JAMA 2011; 305(1): 50-58

44. Cherubini A, Lowenthal DT, Paran E et al. Hypertension and Cognitive Function in the Elderly. Am J Ther 2007; 14(6): 533-554

45. Lucas M, Mekary R, Pan A et al. Relation between clinical depression risk and physical activity and time spent watching television in older women: a 10-year prospective follow-up study. Am J Epidemiol 2011; 174(9): 1017-1027

46. Mammen G, Faulkner G. Physical activity and the prevention of depression: a systematic review of prospective studies. Am J Prev Med 2013; 45(5); 649-657

47. Dictionary of Sport and Exercise Science. Over 5,000 Terms Clearly Defined. London: A & B Black; 2006

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