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The Effect of 12-Weeks of Fitness Program on Physical Fitness Metabolic Risk Factors, and COGNITIVE FUNCTION of Aged Women with Mild Dementia

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Abstract

Purpose: *This study analyzed the effects of a Fitness Program, which combines anaerobic and aerobic exercises applied for 12 weeks, on changes in physical fitness, metabolic risk factors, and cognitive function of elderly women aged 65 or older.*

Method: *20 elderly women aged 65 or older were recruited as the subjects of the study and assigned into 2 groups: the Control Group and the Fitness Program Group, which carried out the exercise. The Fitness Program Group carried out exercises the full-body resistance exercise using a weight machine for the upper and lower extremities, working on from large to small muscles under the supervision of a professional sports instructor, four times a week for 12 weeks. After the resistance exercises were carried out, walking was performed for 30 minutes on a treadmill without slope at a speed of 5.4(km/h). The intensity of the exercise was reset by measuring the RM (repetition maximum) every three weeks.*

Results: *The Fitness Program Group showed a decrease in weight, body fat, and body mass index compared to the Control Group. The Fitness Program Group showed an increase in muscle mass and displayed interactional effects between the group and repeated measurements($p<0.05$). In terms of cognitive function, the Fitness Program Group showed an increase in memory over the Control Group, and both groups showed an increase in treatment at neural reaction speed and displayed statistically significant($p<.05$) interactional effects. Both groups showed positive increases in simple and selective reaction times($p<.05$).*

Conclusion: *It could be confirmed that systematic and regular exercise in old age has a positive effect on body composition and physical fitness. It is predicted that the nerve reaction time, especially in cognitive function factors, has been improved by nerve stimulation. It would be meaningful if future studies compare various aspects of the study subjects, analyze physical fitness factors related to aging, and evaluate cognitive function factors for the prevention of dementia.*

[Keywords] ***Elderly Women with Mild Dementia, Fitness Program, Physical Fitness, Metabolic Risk Factors, Cognitive Function***

1. Introduction

The performance of age-appropriate exercise and regular participation in physical activity give one's life a boost and have a positive effect on health. Regular exercise is known to be effective in delaying physical and mental aging[1]. Since modern medical technology developed and the positive effects of exercise became known to the public, the average life expectancy has been increasing due to the interest in health and active participation[2].

The decrease in physical fitness among older people leads to a decrease in the ability of physical activity, which is known to be about 25% lower than in their youth[3]. The decrease in the ability of physical activity may lead to difficulties in carrying out normal daily life or even death due to weakened cardiovascular and musculoskeletal systems[3].

As such, physical changes due to aging are likely to result in decreased physical activity and obesity caused by an imbalance in energy consumption[4]. And it turned out that older women have a higher average life expectancy than men and have a higher incidence of dementia due to metabolic risks and decreased cognitive function[5].

A major cause of obesity is known to be the intake of excessive energy and an imbalance in consumption[6][7]. Complications due to obesity vary widely and mainly related to dyslipidemia with the increase in low-density lipoprotein cholesterol(LDL-C) and the decrease in high-density lipoprotein cholesterol(HDL-C)[8]. These complications lead to various diseases and lowering quality of life and often result in death[9][10]. Therefore, the need to lower the prevalence of obesity is emphasized and much attention is required for active management and prevention of obesity.

Recent reports have suggested that the symptoms that are becoming more serious than obesity are sarcopenia[11]. Sarcopenia inhibits the ability to perform physical activities and independently leading one's daily life, which, along with the reduction of lean body mass and the increase in body fat, results in physical weakness[12]. Regular physical activity and exercise have been reported to improve muscle strength, muscle endurance, and flexibility even in old age[13][14]. In particular, referring to prior studies on the effect of carrying out exercises fitted to individual characteristics using scientific measuring tools, Park(2017) conducted a combined exercise program three times a week for 12 weeks with 60-70% HRR, Jeong(2017) conducted a circular exercise program three times a week for 12 weeks with 60-80% HRR, and Lee(2019) conducted Pilates exercise three times a week for 12 weeks to analyze changes in physical fitness factors, which all produced different results[15][16][17]. The increase in obesity caused by lack of physical activity and exercise for the elderly is a social problem, and more research and support related to physical fitness is needed to provide Fitness Programs by setting the types, frequencies, forms, and times of various exercises, especially for the elderly women.

A study by Dufour AB(2013) suggested that a decline in physical activity resulted in a negative change in body composition due to a decrease in lean body mass and an increase in body fat[12]. The imbalance in body composition caused by changes in lean body mass and body fat is especially responsible for the increase in cardiovascular disease prevalence, which can cause metabolic risk factors resulting from reduced physical fitness[18][19][20]. Long-term metabolic risk factors are related to the risk of developing disorders resulting from complications and aftereffects and tend to occur with the risk of high blood pressure and glucose levels, so continuous care is needed[21]. Ahn(2020) that the elderly with obesity who performed a 12-week exercise program had significantly improved waist measure, systolic blood pressure, and HDL-C concentrations, as well as significantly improved physical fitness-related factors[22]. These results show that exercise is an effective way to treat and prevent metabolic risk factors in older women.

Cardiovascular risk factors such as hypertension, diabetes, and hyperlipidemia are known to affect the pathological mechanisms of cognitive function degradation[23]. The increase in body mass index also increases brain health risk factors, which are more pronounced in women than in men[24]. Meanwhile, studies have shown that cardiovascular diseases caused by metabolic risk factors are associated with stroke and cerebral infarction with no symptoms Galego J(2005) and that the higher the prevalence of cardiovascular diseases, the more pigmentation in gray substance of the brain[25][26]. It has been reported that the pathogenesis is that it is caused by ischemic damage to the subcortical gray matter and the white matter of the brain, which is responsible for sensory, motor, and speech functions, caused by the stenosis of the vascular lining and abnormality of automatic regulation of brain blood flow[27]. These factors may cause dementia, among which most common types are Alzheimer's and vascular dementia, and other neurological disorders include Parkinson's disease[28].

Dementia begins with a decline in cognitive function, resulting in multiple cognitive disorders, such as time and space disorders and speech disorders, resulting in constraints on daily activities[29]. Physically, it may cause accidents such as falls, which in turn increase the risk of fractures, and also cause mental disorders, affecting independent activities[30]. It is difficult to distinguish between dementia and memory loss from normal aging, as the decline in cognitive function due to aging appears in the form of memory impairment and orientation disorder, which are also minor symptoms in the early stages of dementia. However, if these symptoms occur continuously in everyday life, one should pay attention to them because they can be seen as symptoms of mild dementia[31]. Many pharmacological studies are underway to delay dementia, but they do not provide clear and definite results, and the methods applied to prior studies in non-pharmacological ways are focused on a uniform and fragmentary activity program that identifies physical, visual, or auditory stimuli reactions occurring in daily life[32]. Studies on improving cognitive function for the elderly are actively being conducted, but mainly the results for the cognitive function of the healthy elderly are being published. In particular, there is a lack of research on elderly women, especially on those with mild dementia.

In a prior study, Kwak(2005) that memory and cognitive function improved when aerobic exercise was applied to dementia patients, and Ahn(2017) showed positive results by analyzing changes in BDNF and Tau, which involved the action of the brain's neuroendocrine system and complex pathogenesis, in saliva after applying resistance exercise using an elastic band to the elderly with dementia[33][34].

Therefore, this study analyzed how changes in body composition and metabolic risk factors were related to cognitive function in the process of regularly carrying out the Fitness Program, which combined resistance and aerobic exercises, for elderly women with mild dementia symptoms. In particular, it was analyzed to derive the results of changes in memory, nerve movement speed, simple reaction time, and selective reaction time, indicating the brain neuro-functions.

Thus, the purpose of this study is to provide basic data for designing exercise programs suitable for the physical fitness and metabolic risk factors of female senior citizens by verifying that changes in the physical and metabolic risk factors of female senior citizens through the implementation of a 12-week Fitness Program are related to their cognitive function.

2. Research Methods

2.1. Research subjects

The subjects of this study were female elderly people aged 65 or older living in D Metropolitan City and those who had no internal or surgical problems in medical interviews and examinations over the past six months but had mild dementia symptoms. 20 elderly women with no exercise experience were randomly selected and divided into the Control Group(n=10) and the Fitness Program Group(n=10). After fully explained the purpose and method of the study, they wrote a consent form and participated in the experiment. The characteristics of the study subjects are as follows <Table 1>.

Table 1. The characteristics of the study subjects.

	Age(yr)	Height(cm)	Weight(kg)	%fat
Control group	66.1 ±2.51	152.1 ±4.08	60.6 ±5.36	37.5 ±4.70
Fitness program group	66.7 ±2.79	152.0 ±4.37	59.0 ±6.27	38.9 ±3.62

2.2. How the fitness program were conducted

The exercise program for this study was carried led by a professional sports instructor who holds a certificate of first aid in case of on-site emergencies. A weight machine and treadmill were used for the exercise and applied only to the Fitness Program Group. The study subjects did not have experience in exercising using a weight machine, so they were instructed by the professional sports instructor for a week and began exercising after being familiar with it. At 9 a.m., all members of the Fitness Program Group gathered to stretch for 10 minutes before the start of the main exercise, and the resistance exercise using the weight machine was divided into the upper and lower body and conducted four times a week for 12 weeks. The exercise was done in the order of large to small muscles, and abdominal exercise was performed whenever the Fitness Program was conducted, regardless of the progress of upper and lower body exercises. Following the end of the weight machine exercise, aerobic exercise was performed at a speed of 5.4(km/h) for 30 minutes on a treadmill with no slope. The intensity of exercise was reset by measuring the Repetition Maximum(RM) every three weeks. The details of the Fitness Program is as follows <Table 2>.

Table 2. Fitness program.

	Type	Intensity	Time(min)
Warm Up	Stretching	-	10
Upper body (1Day)	Flat bench press machine	1RM 60~70% 15rep, 3set	30
	Lat pull down machine		
	Shoulder press machine		
	Cable biceps curl		
	Cable triceps curl		
Lower body(2-Day)	Stead leg press machine		
	Smith machine squat		
	Leg extension machine		
	Leg curl machine		
	Standing calf raise machine		
Abdominal exercise (4-Day)	Crunch	30rep, 3set	
	Leg raise		
Aerobic exercise	Treadmill	Grade(%) 0.0	30
		Speed(km/h) 5.4	
Cool down	Stretching	-	10

2.3. Measurement items and analysis methods

2.3.1. Body composition

Body composition was measured by using Inbody 720(Inbody, Korea) for weight, body fat, and lean body mass through microcurrent of at least 1 kHz up to 1000 kHz.

2.3.2. Measuring physical fitness

The physical fitness measurement was based on studies by Ahn(2019), including Grip Strength, Back Muscular Strength, Sit Up, and Sit and Reach. After the Harvard Step Test used for whole-body endurance measurement, the formula for cardiopulmonary endurance measurement was applied to calculate the value of the Physical Efficiency Index(PEI)[35]. To measure muscular strength, the average value of grip strength was recorded by using an electronic grip force gauge(TKK, Japan) for 2 to 3 seconds from the left and right hand. To measure back muscular strength, a measured value using an electronic back muscular strength meter(TKKK, Japan) was recorded, and sit-ups were performed for 60 seconds to measure the muscular strength and endurance of the abdomen. For flexibility measurement, Sit & Reach was performed using a long-sitting trunk forward flexion gauge. The subjects straightened their knees with bare feet and raised their ankles to reach the vertical surface of the measuring instrument, and then put their hands together to bend their upper bodies forward to record the measurements in 0.1cm increments when the upper body was extended as much as possible with both middle fingers. The measurements for all the items were taken twice and the highest was used.

Harvard Step Test was conducted to assess cardiopulmonary endurance. At the speed of 30 steps per minute on the 35cm-high platform, the subjects were made to continue the steps for exactly 5 minutes. Immediately after the Harvard Step Test, PEI was calculated by recording the pulse rate measured in the radial artery for a period of 1 minute to 1 minute 30 seconds, 2 minutes to 2 minutes 30 seconds, 3 minutes to 3 minutes 30 seconds as soon as the test was completed.

PEI = (180 seconds / 2 × 3 times the total of beats) × 100

2.3.3. Analysis of metabolic risk factors

When the subjects were stable, they maintained an empty stomach for 12 hours and collected 10 ml of blood from the upper arm veins using a syringe. Immediately after the blood collection, it was heparin treated to prevent coagulation, and centrifugation was performed for 10 minutes at a temperature of 4°C at 3,000 rpm. The plasma and serum were separated from the centrifuged blood and stored in a deep freeze at –80°C. Total cholesterol(TC), high-density lipoprotein cholesterol(HDL-C), triglyceride(TG), and blood glucose were analyzed with COBAS 111, an electrodynamic analyzer(the U.S.A.).

Systolic and diastolic blood pressure were measured with a mercury blood pressure gauge (MDF 800, USA) at a sitting position that matched the cardiac height and arm height of the subject. A total of two measurements were taken two to three minutes apart, and if there was a difference of 5mmHg or more, an additional one was re-measured and the average value of the 3 measurements was calculated.

The waist measure was measured to assess abdominal obesity. Measurements were made using a tape measure in the middle of the lowermost rib region and pelvic iliac crest with both feet 25 to 35 cm apart from each other with the upright position where the subject gazed forward[36]. Measurements were taken so that the tape measure did not put pressure on the soft tissue and were recorded up to 0.1cm.

2.3.4. Cognitive function test

The cognitive function test was conducted using the Concussion Vital Sign Test, which was used as a cognitive function evaluation tool in the United States. A total of four types of measurement items were evaluated: memory, nerve movement speed, simple reaction speed, and selective reaction time. The subject entered a one-person intensive training room with a computer with the program connected to it, and the test was conducted, and the manager monitored it in real-time on the screen. After the test was completed, the items' scores were added together and the values sent to the central control unit were analyzed.

2.3.4.1. Memory

This is a test to assess whether language or shapes are well recognized, remembered, and recalled, and conducted with topics such as language learning, language memory, word recognition, short-term memory, long-term memory, graphic knowledge memory, image recall, and mechanical device manipulation. Measurements were made for three minutes.

2.3.4.2. Nerve movement speed

This was done by checking for problem recognition, perception of received information, response, and participation, including distraction, driving motor nerves, work capability accuracy, and obsessive-compulsive disorder. Measurements were made for four minutes.

2.3.4.3. Simple reaction time

This examined the ability to respond to and process simple information quickly within a given time frame, with items of time taken to engage in dialogue, track simple instructions, and respond or make decisions. Measurements were made for one minute.

2.3.4.4. Selective reaction time

This examined the ability to continuously respond and process simple information over a given period of time, with items of time taken to make simple command reactions and decisions. Measurements were made for five minutes.

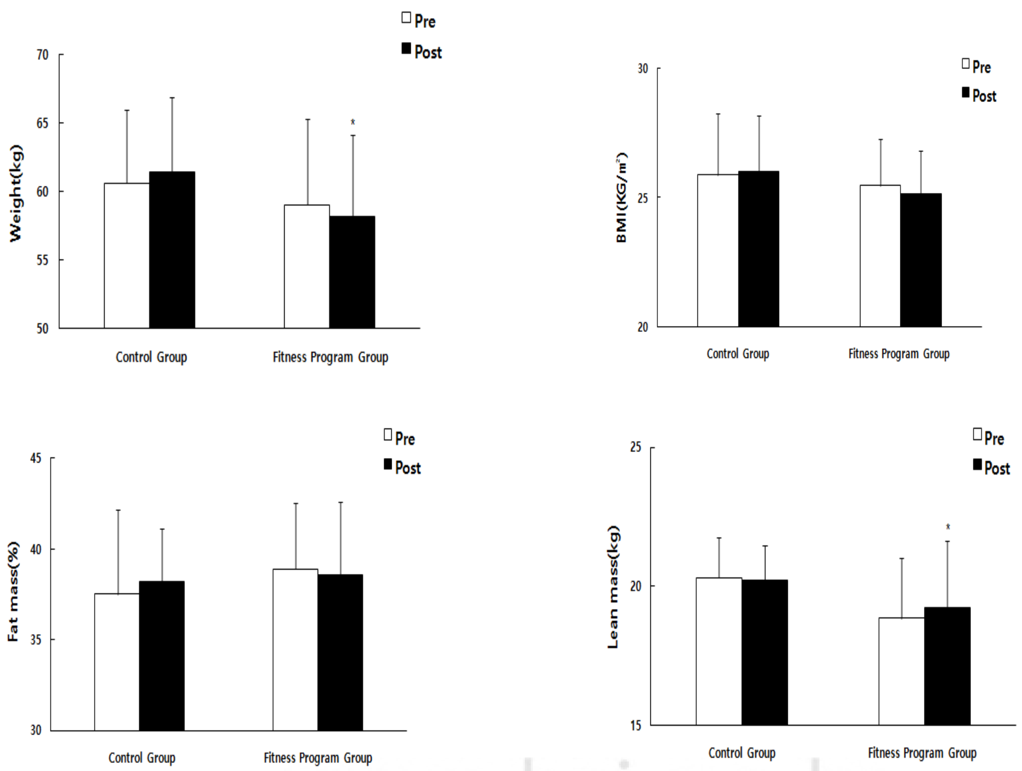
2.4. Data processing method

In this study, data processing was used to calculate the mean and standard deviation of each measurement item using the SPSS 20.0 statistical program. A two-way ANOVA (RG (2) × RM (2)) was performed to analyze the main effects and interactional effects to verify the differences between groups and repetitions during the 12-week Fitness Program. For significant interactional effects, a post-test was performed between paired t-test and inter-group t-test by period. All statistical significance levels are set to $p<0.05$.

3. Results

3.1. Changes in body composition

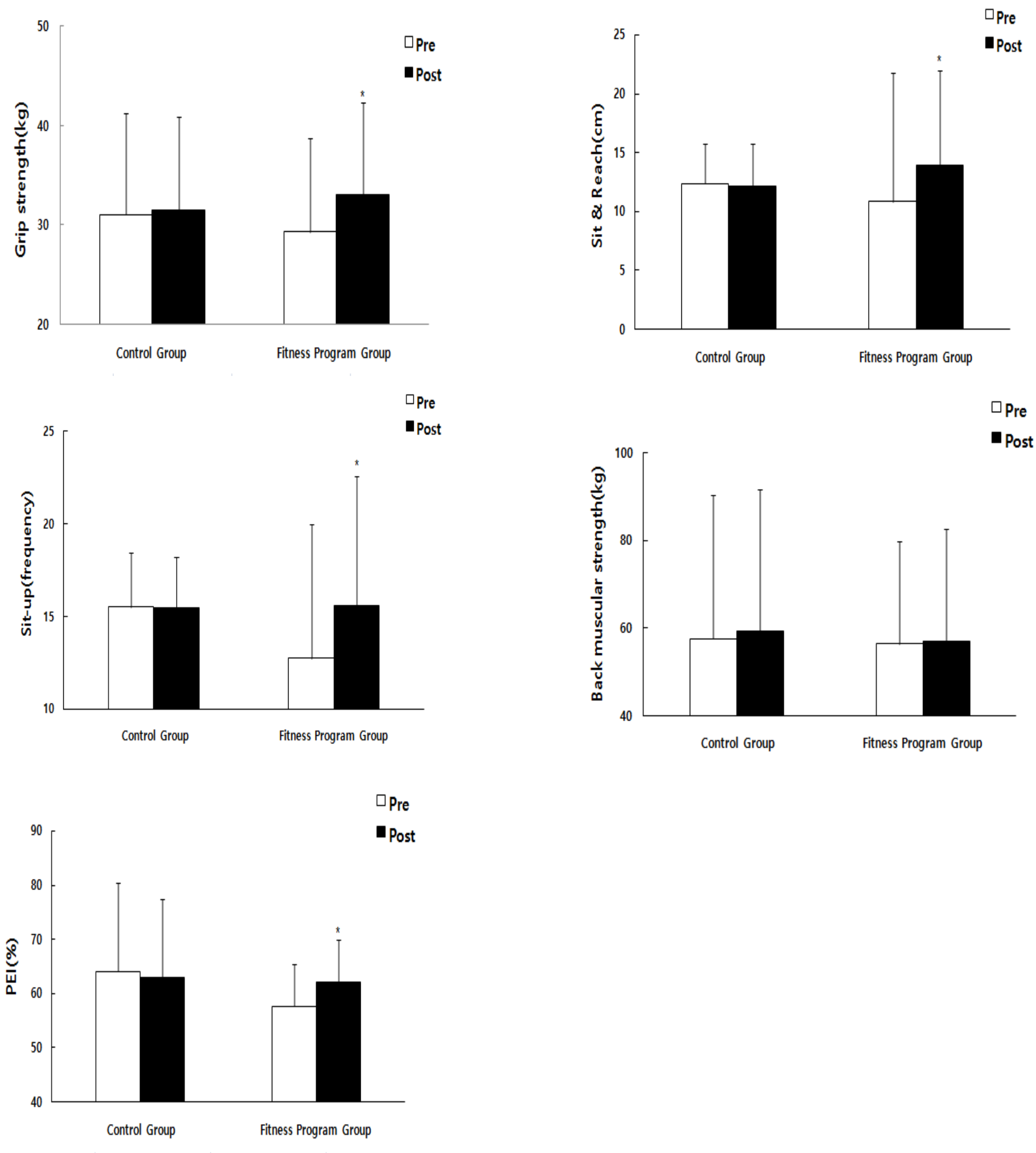
Figure 1. Changes in body composition.



Note: Values are mean and SD, * p<0.05. As shown in Figure 1, the analysis of the changes in body composition resulting from the implementation of the Fitness Program for 12 weeks in older women with mild dementia showed a decrease in body fat and body mass index in the Fitness Program Group and a slight increase in the Control Group as shown in Figure. 1, but there was no statistically significant difference. As to the body weight, the Fitness Program Group decreased, and the Control Group increased, resulting in a significant interaction between the groups and the periods(p<.001). In terms of lean body mass, the Fitness Program Group increased, and the Control Group showed a slight increase, showing an interactional effect between the groups and periods(p<0.05).

3.2. Changes in physical fitness

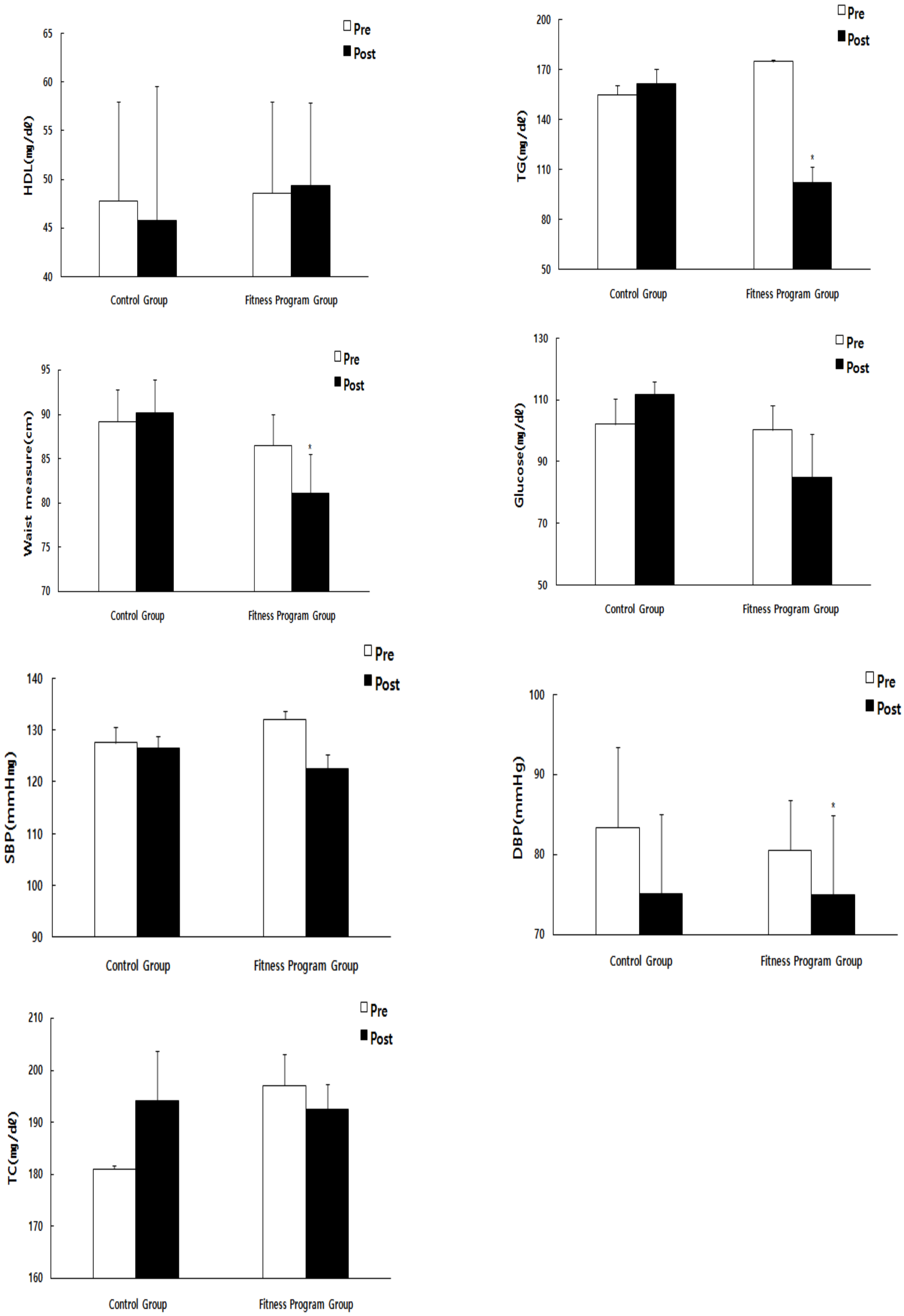
Figure 2. Changes in physical fitness.



Note: Values are mean and SD, * p<0.05, PEI : physical efficiency index. As shown in Figure 2, as a result of analyzing the changes in physical fitness from the imple mentation of the Fitness Program for 12 weeks in older women with mild dementia, in the muscle strength measurement item of Grip Strength, the Fitness Program Group showed significant effects over time(p<0.05). The back muscular strength indicated a small increase over time, but no significant difference was seen. In the muscle endurance measurement item of Sit-up and the flexibility measurement item of Sit & Reach, the Fitness Program Group showed significant effects(p<0.05). After the Harvard Step Test to measure cardiopulmonary endurance, PEI, which was measured in the radial artery, showed significant effects in the Fitness Program Group(p<0.05).

3.3. Changes of metabolic risk factors

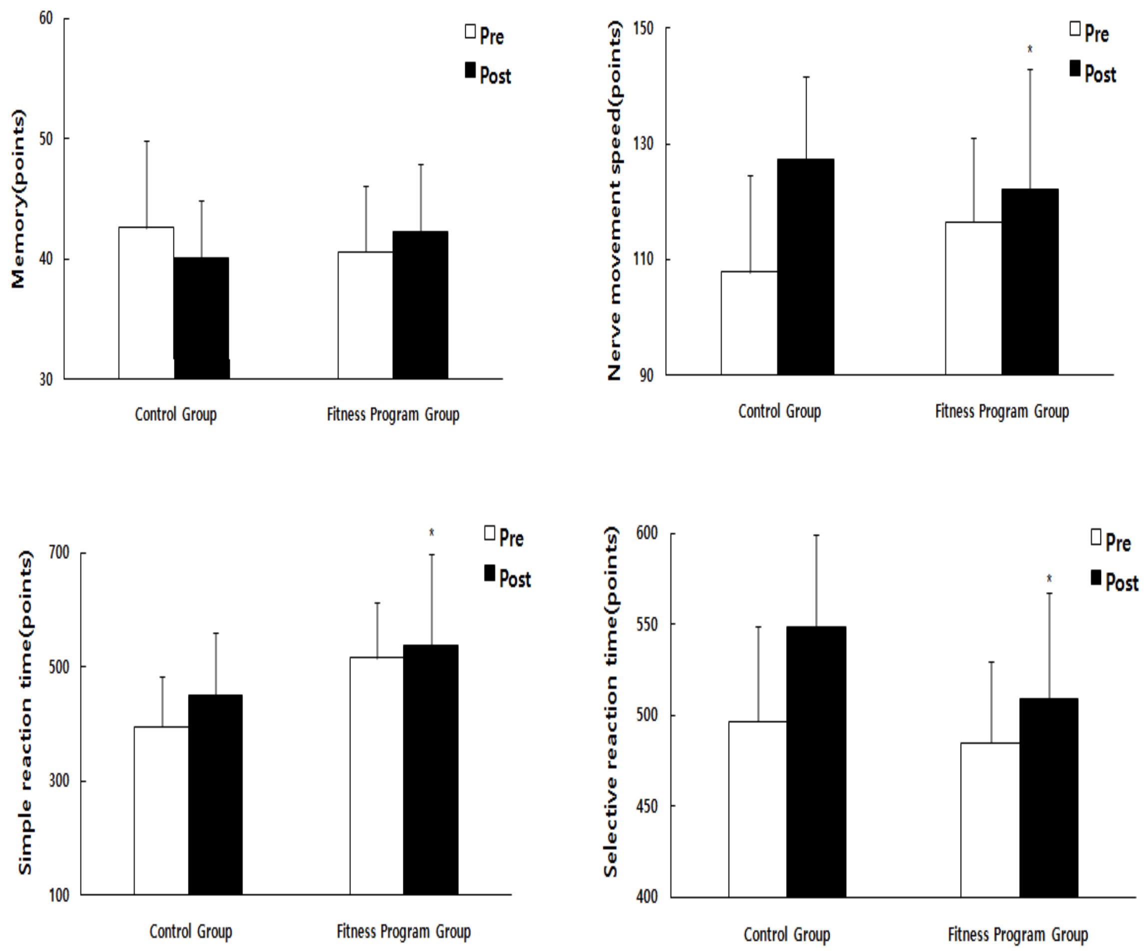
Figure 3. Changes of metabolic risk factor.



Note: Values are mean and SD, * p<0.05. As shown in Figure 3, an analysis of changes in metabolic risk factors from the implementation of the Fitness Program in older women with mild dementia for 12 weeks showed increases and decreases in the results of blood pressure and TC, but no statistically significant interactional effects. For TG, there was a statistically significant interactional effect(p<0.05), showing a significant decrease in the Fitness Program Group. For HDL-C and glucose when the stomach was empty, it showed positive changes in the group that performed the Fitness Program, but there were no statistically significant interactional effects. The waist measure of the Fitness Program Group was significantly reduced, and a small increase in the Control Group, showing the interactional effect between the group and periods(p<0.05).

3.4. Changes in cognitive function

Figure 4. Changes in cognitive function.



Note: Values are mean and SD, * p<0.05. As shown in Figure 4, an analysis of changes in metabolic risk factors from performing the Fitness Program for 12 weeks in older women with mild dementia showed no statistically significant interactional effects, although for memory, the Fitness Program Group increased and the Control Group decreased. For nerve movement speed, both the Fitness Program Group and the Control Group showed an increase with the exercise and displayed statistically significant interactional effects(p<0.05). Meanwhile, both groups showed positive increases in simple and selective reaction times, and only repeated measurements showed statistically significant differences(p<0.05).

4. Discussion

The results have been published in many prior studies on changes in the proportion of body composition, such as weight, body fat, and lean body mass, after diet control and continuous physical activity or steady exercise participation. A decrease in weight and body fat and an increase in lean body mass result in a change in appearance, which brings emotional stability. A lot of women said that they felt a gap between the ideal body required by society and the body in reality[37]. When participating in sports for the purpose of changing body composition and managing body shape, they recognize participation in the exercise as a means of consuming calories and once the goal of reducing weight is achieved, they tend to neglect exercise. So, a systematic and continuous exercise program is required[38]. To compensate for the problems pointed out in the preceding studies, this study provided a 12-week Fitness Program to elderly women with mild dementia to provide a program for the persistence of exercise and to verify changes in body composition and their effects. As a result, the body fat and mass index decreased in the Fitness Program Group, and the lean body mass increased slightly. Ahn(2020), who reported the results of a study where exercise treatment was applied to obese women, is believed to be able to support these findings. As these studies have shown, the stimuli of exercise have a positive effect on body composition, which in turn affects physical, physiological, and neurological changes[22].

The practice of regular exercise, which is a non-pharmacological approach, has been shown to improve physical function including muscle strength, muscle endurance, cardiopulmonary endurance, flexibility, and body composition, and positive changes to pathological factors such as IGF-1, an independent risk factor for sarcopenia, and IL-6, an inflammatory cytokine, have affected aging delays[39]. In this study, the average grip strength of both hands was measured as a muscle strength factor, muscle endurance was measured with sit-ups. Trunk forward flexion was performed to measure flexibility. Harvard step was performed to measure the systemic endurance, and the PEI indicating cardiopulmonary endurance was measured. All these indicate that there were significant changes after performing the exercise program. Although there was no significant difference in back muscular strength, it resulted in a small increase in the Fitness Program Group, which was consequently consistent with a prior study by Jorge(2011) The Fitness Program, conducted in this study, is thought to have improved physical abilities such as muscle strength, muscle endurance, the systemic endurance, and flexibility with resistance exercise using a weight machine stimulating the musculoskeletal system and the aerobic walking exercise on a treadmill with a constant speed of 5.4 km/h[39]. These results are considered to be applicable to programs that would improve the physical fitness of older women to prevent sarcopenia.

The decline in physical fitness is caused by environmental changes, especially constraints on physical activity and dietary habits, which cause metabolic diseases, but exercise improves or delays metabolic risk factors. There are prior studies that have identified the effects of exercise related to these findings. Ahn(2020)'s study showed that the medium-strength elastic band exercise program was applied to the elderly for 16 weeks, and the concentration of plasma SAA-C, a non-functional HDL-C, which is a metabolic risk factor, and plasma HSP70, a cell recovery factor, were improved after exercise[22]. In a study by Kim(2017), the interactional effect between groups and periods was shown in glycated hemoglobin, a metabolic risk factor in the blood, as a result of walking exercise in medium intensity for eight weeks considering individual differences among elderly women[40]. In this study, the levels of waist measure, blood pressure, total cholesterol in the blood, triglycerides, and glucose were analyzed to determine the effect of the implementation of the Fitness Program on metabolic risk factors. The analysis showed statistical differences in waist measure, triglycerides, and diastolic blood pressure. Other factors indicated positive increases and decreases, but there were no statistically significant differences.

A prior study by Katzmarzyk(2003) of 105 participants with metabolic syndrome also demonstrated that exercise had positive effects on waist measure, blood pressure, HDL-C, triglycerides, and fasting blood sugar[41]. Jeong(2010) conducted an experiment on 104 elderly people with anaerobic exercise using elastic bands and aerobic exercise of sports dance for 24 weeks and found that internal fat and diastolic blood pressure decreased significantly[42]. These inconsistencies with the results of this study can be seen in the preceding studies, which are believed to have differed between the characteristics of the study subjects to slightly lower risk levels in the metabolic risk criterion and the duration of the treatment. Interestingly, statistically significant differences in waist measure, blood pressure, and triglycerides could prove that the application of the Fitness Program to older women is effective to improve metabolic risk factors.

An increase in metabolic risk factors can lead to decreased physical fitness, which begins with sedentary life habits and inadequate nutrition and in turn leads to deterioration of cognitive function[43].

Reduced cognitive abilities accelerate dementia and degrading brain health, causing nerve damage[44]. However, regular exercise is part of a healthy lifestyle and can not only improve cognitive function but also delay the development of dementia[45]. A prior study to support these findings reported that regular aerobic exercise on a treadmill done by young and old rodents significantly improved brain nerve function[46]. As a result of the cognitive function identified in this study, the cognitive function of performing the Fitness Program for 12 weeks in older women with mild dementia showed positive effects in memory, nerve movement speed, simple reaction time, and selective reaction time. It also showed interactional effects at nerve movement speed and statistically significant differences in simple and selective reaction time. Looking at prior studies to support this result, Ahn(2019) reported that the elderly women's resistance exercises using bands and walking for 60 minutes three times a week resulted in improved physical fitness and cognitive function, while Teri L(2015) reported that the combined exercise of 153 subjects suffering from dementia had improved their behavioral disorders and cognitive function[35][47].

In Korea, the Mini Mental State Examination Dementia Screening(MMSE-DS) method, which is conducted under the supervision of experts, is most commonly used to analyze cognitive function, but there are some difficulties to discuss compared to the results of this study without clarifying the distinct expertise, reliability, and validity of the evaluation method. It is thought that the MMSE-DS used in the preceding study of Ahn(2019) was composed to evaluate with a total of 19 questions in five sections, including orientation, memory recall, and concentration(3 questions), language function(3 questions), and composition interpretation and judgment(3 questions), showing a similar tendency to this study[35].

Cechetti(2012) supports the results of this study by reporting in the exercise program set considering the characteristics of the elderly that anaerobic exercise could prevent sarcopenia by maintaining muscle mass and strength and aerobic exercise could have a positive effect on antioxidation, nerve development, and cognitive function. Prior studies that evaluated the cognitive function of the elderly through the Concussion Vital Signs Test used in this study are insufficient, so it is difficult to verify the effects[48]. However, the results of neural velocity transferred from the central nervous system to the peripheral nervous system for muscular contraction and exercise with a weight machine applied in this study could indirectly confirm the effects of muscle fiber contraction speed reduction, and it is believed that aerobic exercise on a treadmill improved the plasticity of the brain nerve. However, it is judged that the improvement of results from adaptation to the Concussion Vital Signs Test program through repeated measurements cannot be ruled out. The active use of this research method would provide the basic data for cognitive function tests using non-face-to-face methods considering COVID-19 in addition to using face-to-face questionnaires conducted by experts.

5. Conclusion

This study analyzed the changes in body composition, physical fitness, metabolic risk factors, and cognitive function in elderly women with mild dementia with 12 weeks of a Fitness Program, and the results are as follows. In all items of body composition, changes in weight and lean body mass were statistically significant through the performance of the Fitness Program, confirming the interactional effects of exercise. For changes in physical fitness, there were significant effects($p<0.05$) in the Grip strength, Sit-up, Sit & Reach, and PEI. Although no significant differences were found in the back muscular strength, the results showed an increase. The changes in metabolic risk factors can be seen as interactional effects of increased physical fitness, with significant interactional effects in TG and waist measure. However, there were no statistically significant differences in TC, HDL-C, and blood glucose, but positive results are judged to be the result of performing the Fitness Program. Among the cognitive function assessment items, significant differences($p<0.05$) were found in nerve movement speed, simple reaction time, and selective reaction time, confirming the effectiveness of the 12-week Fitness Program.

The decisive factor in these findings is thought to be the nature and intensity of the exercise program. In further research, it is thought to be able to get a clearer analysis of cognitive function and brain function if various subjects and more specialized exercise programs are developed and applied, and the intensity of application by type of exercise is specified. Further research on pathophysiological mechanisms related to brain function would also be meaningful.

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7. Appendix

7.1. Authors contribution

	Initial name	Contribution
Lead Author	GHL	-Set of concepts ☑ -Design ☑ -Getting results ☑ -Analysis ☑ -Make a significant contribution to collection ☑ -Final approval of the paper ☑
Corresponding Author*	KJK	-Corresponding ☑ -Play a decisive role in modification ☑ -Significant contributions to concepts, designs, practices, analysis and interpretation of data ☑ -Participants in Drafting and Revising Papers ☑ -Someone who can explain all aspects of the paper ☑