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Development and effect of a cognitive enhancement gymnastics program for elderly people with dementia

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The purpose of this study was to develop a cognitive enhancement gymnastics program for the elderly with dementia and to verify its effect. The study was conducted on 27 people with dementia being treated in a dementia day care center in Incheon city. No statistically significant differences were found in the measures Mini-Mental State Examination for Dementia Screening (MMSE-DS), Short Geriatric Depression Scale (SGDS), Seoul Activities of Daily Living (S-ADL), or rock-paper-scissors. However, the MMSE-DS and rock-paper-scissors showed improvement after 12 weeks.

Keywords: Cognitive enhancement gymnastics program, Elderly people, Dementia, Rock-paper-scissors, Development and effect

INTRODUCTION

The elderly population increased rapidly to 12.7% in 2014 (Statistics Korea, 2014); in 2017, 14% of the total population are expected to contribute to the aged society. Thus, as the aging of the population progresses rapidly, age-related diseases such as hypertension, diabetes, and dementia lead to increased medical expenses. This social and economic burden has become a serious social problem. For example, 12 million people worldwide are suffering from dementia, which is characterized by degraded intelligence due to cerebral disease, for example, Alzheimer disease (AD) or vascular dementia. According to the World Health Organization (WHO), the prevalence rate of dementia among the elderly in Korea in 2014 was 9.58% (0.61 million). Furthermore, the WHO predicts that it will reach 10.39% (0.84 million) in 2020 and increase to 15.06% (2.17 million) in 2050 (Statistics Korea, 2014).

The rapid increase in the number of elderly dementia patients has caused several serious problems, such as increasing social and economic burden, worsening health status, and exacerbating other diseases. In particular, the increase in associated financial burden has become a predicament for the government. Accordingly, as an alternative for cutting costs and to solve the health problem, the importance of physical activity and regular exercise has been emphasized. A large body of research has reported that people can maintain physical function and health-related physical fitness through regular physical activity (Kemoun et al., 2010). Furthermore, as shown in studies on exercise and cognitive function, exercising not only helps improve cognitive function in the elderly but also has a significant effect on the elderly with health issues or dementia. Low intensity strength training for seniors who spend a lot of time sitting also yields physiological benefits, and some studies showed that strength training with low intensity once or twice a week helps improve cognitive function (Colcombe and Kramer, 2003). These studies confirm that strength training is effective in improving impaired cognitive functions of the elderly.

Recent studies have focused on establishing the impact on the

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nervous system and the cognitive benefits associated with exercise. In particular, aerobic exercise helps to facilitate nutrition supply to the capillaries and increase cerebral blood flow and brain cell growth, thus inhibiting decrease in brain cells. In addition, regular exercise is effective in preventing falls in elderly with dementia who have low muscular function and impaired balance by improving physical functions such as endurance, lower extremity strength, and balance. Exercise over a long period of time increases oxygen transport and energy resources by holding blood vessels of the brain and improving the growth and function of brain cells. Consequently, regular exercise has a positive effect on blood vessel function of the brain and contributes to strong psychomotor abilities (Lee et al., 2012; Um et al., 2004).

Hong (2012) confirmed that performing daily aerobic exercise, which was oriented mainly toward walking 2–3 times a week and more complex exercises consisting of resistance exercise using dumbbells and elastic bands, could improve physical function and activities of daily living. She also found that yoga had a positive effect on strength, muscle endurance, and cardiovascular endurance of elderly with vascular dementia.

Thus, research related to health of the elderly has been conducted due to the rapid aging of the population in Korea. However, studies of the elderly with dementia have been very limited. Nonetheless, an important fact revealed by many studies is that regular exercise has a positive effect on dementia, thus, it is essential for this group (Han et al., 2007). This further implies that physical education (PE) plays an important role. Nevertheless, PE does not play a proper role in dementia care centers and hospitals that are managing dementia-related issues, which are mainly focused on medical issues. Furthermore, PE in the field has not even developed any exercise programs for the elderly with dementia, and dementia issues are still being overlooked. However, developing such programs should be considered an urgent task, because customized exercise programs for the elderly with dementia could become a socially useful issue. Verifying the effectiveness of such a program will be able to provide a reasonable and logical basis for applying the program extensively to daycare centers for elderly with dementia and hospitals. Therefore, the purpose of this research is to develop a cognitive enhancement gymnastics program for the elderly with dementia and to verify its effect.

MATERIALS AND METHODS

Subjects

The study was conducted on 27 people with dementia (AD, vascular dementia) being treated in a dementia day care center in Incheon. The subjects were all female. The reason why only women were selected was that only a few men were being treated in this dementia day care center, and these few men refused to participate in the study. The personal characteristics of the study subjects were as follows: average age, 80.93±5.19 yr; height, 147.64 ±6.07 cm; and body weight, 52.10±9.04 kg.

Measurement tools

The study used the following measurement tools for the evaluation of physical and cognitive functions of elderly with dementia.

Measurements of physical strength

Grip strength: To estimate upper extremity muscle strength, the grip dynamometer TKK-501 was used. Subjects lowered their arms naturally in a sitting position, holding the grip dynamometer. While holding the dynamometer with the second joint of the index finger at an almost right angle, we measured the grip strength of the hand.

Movement ability: We measured movement ability with the "Get up and Go" test developed by Mathias et al. (1986). This tool assesses the time it takes to walk 3 m, putting the hand on the thigh while sitting in a chair with a signal "Go," and come back to sit in the chair.

Measurements of cognitive and related functions

Cognitive function: To test cognitive function, the Mini-Mental State Examination for Dementia Screening (MMSE-DS), a unified dementia screening tool, was used. The MMSE-DS is the primary screening tool used by health care centers for early detection of dementia. When a question about the content is presented to the subject, the subject answers or acts exactly in accordance with the tester's instructions. After the question-and-answer, we recorded the results by summing the scores for each subject according to gender, age, and educational background, considering the terms of the score. Inspection items were 10 items about orientation (time, place), two items about memory (memory registration and recall), one item about attention and calculation capabilities, four items about language skills, and two items about understanding and judgment, resulting in a total of 19 questions.

Depression: The Korean version of the Short Geriatric Depression Scale (SGDS-K) was used, which was translated and verified for reliability and validity, to measure the emotional features of dementia according to Cho et al. (1999).

Rock-paper-scissors: In this study, the game "rock-paper-scissors"

was used as an assessment tool for exercising memory. This assessment tool evaluates exercising memory performance of the fragile elderly as described by Lee et al. (2005). Instructors conducted the rock-paper-scissors action three times with the elderly. The subjects were asked to immediately react to the results of the winning action, draw action, and losing action and represent them with their body reaction. Then, we evaluated whether the subjects were able to perform the task operation correctly.

Daily activities evaluation

The Seoul Activities of Daily Living (S-ADL) consists of questions in accordance with cultural characteristics of Korea. It is a tool to evaluate the activities that patients with dementia need to maintain to take care of their body. There are 12 questions in total. This is a proven assessment tool with reliability and validity to assess the domestic abilities of people with dementia.

Development and application procedures of the cognitive enhancement gymnastics program

Program development procedures

The first stage consisted of the planning council that was composed of experts and field research groups to develop the cognitive enhancement gymnastics program. The nine experts comprised two foreign dementia gymnastics development professionals (dementia professional faculties from the Sports University of Japan) and three domestic gymnastics experts for the elderly (dementia movement development and gymnastics development expert), two Daegu Metropolitan city Geriatric Hospital psychology nurses, and two site leaders. We set the aim of this study specifically, that is, the range of motion and subjects and the research range. In addition, we collected literature, foreign case studies, and gymnastics videos related to gymnastics development and analyzed the data. The second step was the organization stage. The program was organized simply considering the physical characteristics of the elderly with dementia and based on the principles of gymnastics. Through more than 10 expert meetings, the gymnastic motions were developed, modified, and supplemented. Specifically, we developed the following cognitive enhancement gymnastics program: warming-up, hand coordination exercise, brain stimulation exercise, walking and stretching, the game of rock-paper-scissors, happy couple, and conditioning exercise in sequence. The specialized part of the program was to ask a professional music composer to complete the music that could easily increase the tempo and emotional effects along the motions of the program. In addition, we wrote the lyrics for the aerobic exercise so that the participants could follow the motions, singing the song. After we completed the combination of gymnastics and music, we modified and supplemented the program three times. The third step was the implementation. The first version of the cognitive enhancement gymnastics program was taught to a professional dementia nurse who was required to demonstrate, carry out, apply, and operate the program. After the professional dementia nurse carried out direct instructions to the elderly with dementia, the nurse provided feedback on various motions through e-mail, telephone, video, conference, and other means. Through this process, the cognitive enhancement gymnastics program was finalized.

Program construction and application

The construction of the cognitive enhancement gymnastics program resulted in a 30- to 40-min program, and the specific information is shown in Table 1.

In this study, the cognitive enhancement gymnastics program for the elderly with dementia was conducted twice a week for 8 weeks. It took 40–50 minutes for each session. The program was instructed by professional nurses of the dementia day care center in Incheon city. The first time, it was carried out in accordance

Table 1. Cognitive enhancement gymnastics program

Exercise	Gymnastics moves
Warm-up (2–3 min)	Shoulder turn, body bend and stretch, body twist, ankle turn, shoulders up and down
Main movement (25–30 min)	- Hand coordination exercise: moving fingers, hand shaking, folding fingers, clench and open fists, cross clench and open fist, fingertips tapping, clap between hands, rock-paper-scissors with both hands, knocking and rubbing thighs
	- Brain stimulation exercise: teeth encounter, turning tongue and eyes, breathing with tongue sticking out, smiling, pulling the ear lobes, stimulating the temple, tapping the head, holding nose and ears
	- Walking and stretching: stretch chest and breathe, stretch neck and back with folding hands, body twist and stretch arms up, shoulders up and down
	- Rock-paper-scissors game: walking, rock-paper-scissors, winning motion. draw motion, losing motion
	- Happy couple: tapping knee and clap, clapping while you walk, tapping with an arm up, beautiful pose, bending arm and stretch
	- Conditioning: holding the end of a hand, bend joints, chest bend and up, rowing position, leg lifting, lifting the heel, balancing with the hips
Cool-down (2–3 min)	Shoulder turn, body bend and stretch, body twist, ankle turn, shoulders up and down

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with singing a song. The second time, it was carried out in a way that the instructors asked questions on things such as date and place and the elderly with dementia answered the questions. The conditioning exercise was performed 10 times for each motion.

Application process of the program

This study was carried out after the researchers visited the day care center in person and sufficiently explained the purpose and procedures to the director of the dementia day care center. The research was conducted with the consent to the research progress.

Data processing method

In this study, we analyzed the data by using the IBM SPSS ver. 18.0 (IBM Co., Armonk, NY, USA). Specifically, we conducted paired *t*-tests to compare performance between pretests and posttest, and to verify the effectiveness of the cognitive enhancement gymnastics program for the elderly with dementia.

RESULTS

Changes in physical function

Analysis on grip power performed before and after the cognitive enhancement gymnastics program is illustrated in Table 2. There was no statistically significant difference in grip strength ($P > 0.05$). The preaverage of the left hand was at 11.01 ± 3.55 and postaverage at 12.46 ± 4.80, and the preaverage of the right hand was at 14.08 ± 7.80 and postaverage at 13.02 ± 3.84.

Analysis of balance performed before and after the program is shown in Table 3. The balance did not show a statistically significant difference ($P > 0.05$). The preaverage of the left hand balance was at 2.57 ± 1.99 and postaverage at 2.84 ± 3.23, and the preaverage of the right hand balance was at 13.21 ± 6.01 and postaverage at 2.43 ± 1.97.

Analysis on gait performed before and after the program is presented in Table 4. The comparison showed statistically significant differences in walking ($P < 0.05$). Furthermore, Table 4 shows that preaverage walk was at 13.32 ± 4.66 and postaverage at 14.97 ± 5.85, confirming that walking speed increased after the program. With these results, we could confirm that the cognitive enhancement gymnastics program had the effect of improving the walking ability of the female elderly with dementia.

The MMSE-DS and SGDS did not show a statistically significant difference between before and after carrying out the cognitive enhancement gymnastics program ($P > 0.05$). The results are shown in Tables 5, 6.

The rock-paper-scissors game and S-ADL did not yield a statistically significant difference between before and after carrying out the cognitive enhancement gymnastics program ($P > 0.05$). The results are shown in Tables 7, 8. For the S-ADL, the preaverage was at 2.81 ± 2.43 and post average at 3.15 ± 2.87, showing a slight increase in daily activity evaluation.

Table 2. Changes of grip power

Item	Pre	Post	*t*	*P*-value
Left hand	11.01 ± 3.55	12.46 ± 4.80	-1.532	0.138
Right hand	13.02 ± 3.84	14.08 ± 7.80	-0.881	0.387

Values are presented as mean ± standard deviation.

Table 3. Changes in balance

Item	Pre	Post	*t*	*P*-value
Left	2.57 ± 1.99	2.84 ± 3.23	0.574	0.571
Right	2.43 ± 1.97	3.21 ± 6.01	-0.733	0.470

Values are presented as mean ± standard deviation.

Table 4. Changes in walking

Item	Pre	Post	*t*	*P*-value
Walk	13.32 ± 4.66	14.97 ± 5.85	2.311	0.029

Values are presented as mean ± standard deviation.

Table 5. Changes of Mini-Mental State Examination for Dementa Screening (MMSE-DS)

Item	Pre	Post	*t*	*P*-value
MMSE-DS	14.74 ± 5.56	15.59 ± 4.75	-1.623	0.117

Values are presented as mean ± standard deviation.

Table 6. Changes of Short Geriatric Depression Scale (SGDS)

Item	Pre	Post	*t*	*P*-value
SGDS	4.42 ± 2.97	4.11 ± 3.25	0.707	0.486

Values are presented as mean ± standard deviation.

Table 7. Changes of rock-paper-scissors

Item	Pre	Post	*t*	*P*-value
Rock-paper-scissors	0.741 ± 1.05	1.00 ± 1.10	-0.942	0.355

Values are presented as mean ± standard deviation.

Table 8. Changes of Seoul Activities of Daily Living (S-ADL)

Item	Pre	Post	*t*	*P*-value
S-ADL	2.81 ± 2.43	3.15 ± 2.87	0.827	0.416

Values are presented as mean ± standard deviation.

DISCUSSION

This study examined the effect of a newly developed cognitive enhancement gymnastics program for the elderly with dementia. The results from the study suggest the following points for discussion.

First, the grip strength among the physical features did not show a statistically significant difference ($P > 0.05$). These results imply that the increased physical activity within a short period was not enough to improve physical strength of elderly people with dementia. These results are not surprising because the cognitive enhancement gymnastics program was conducted only for a short period of 12 weeks. However, physical functional enhancement when physical activity is carried out for a long-term period has been shown in many previous studies. This study proved that physical activity has a positive effect on the strength of elderly people regardless of the fact that they have dementia. In that respect, the cognitive enhancement gymnastics program, an entire body workout, serves as physical activity that can enhance the strength of elderly with dementia. These results are supported by the fact that grip strength changed slightly from preaverage at 11.01±3.55 to postaverage at 12.46±4.80 in the left hand and from preaverage at 13.02±3.84 to postaverage at 14.08±7.80 in the right hand after conducting the program. Therefore, it is necessary to verify these results by performing the program continuously for a long-term period with elderly who have degraded cognitive function due to dementia.

Second, a nonsignificant difference in balance was observed ($P > 0.05$). The post average (2.84±3.23) was higher than preaverage (2.57±1.99) on the left side, and the post average (3.21±6.01) was higher than the preaverage (2.43±1.97) on the right side. In the study conducted by Han et al. (2014), who carried out a physical activity program 3 times a week for 8 weeks, the balance capability increased significantly.

Third, gait showed a statistically significant difference ($P < 0.05$). The preaverage was at 13.32±4.66 and post average at 14.97±5.85, indicating that the average gait speed increased. These results demonstrated that the cognitive enhancement gymnastics program exerted a distinct effect on gait ability in elderly women with dementia. Furthermore, these results are consistent with results from the study by Kwak et al. (2008), who carried out a whole-body vibration exercise for elderly with dementia over 10 weeks. The test confirmed a significant difference from those who did not exercise. In addition, Lee et al. (2012) reported that gait capability and balance function improved through a 16-week program. These findings demonstrate that the physical motions from gait and happy couple gymnastics among the main exercises of the cognitive enhancement gymnastics program improved gait capability and balance sense.

Lastly, among the cognitive function, the MMSE-DS, SGDS, rock-paper-scissors, and S-ADL did not yield any statistically significant differences. In the MMSE-DS, the postaverage (15.59±4.75) was higher than preaverage (14.74±5.56). These results correspond with the report by Kim and Kim (2012) made from a study in which cognitive function improved through physical activity in small groups. These results indicate that the cognitive enhancement gymnastics program, a whole body exercise, has the potential to exert a positive effect on cognition. In the case of the SGDS, the score was lowered from preaverage (4.42±2.97) to postaverage (4.11±3.25). Additionally, in the case of rock-paper-scissors, the scores increased from pre-average (0.741±1.05) to postaverage (1.00±1.10).

Many studies have reported that physical activity reduces depression. This suggests that physical activity has a positive psychological effect on elderly with dementia. Moreover, in this study, the potential that the proposed activity can reduce depression is significant in the way that the cognitive enhancement gymnastics program was created in combination with soft and rhythmical music. In general, many people often exercise without music. Choi et al. (2010) demonstrated that through a dance movement therapy program, the physical activity along with the music reduced depression and led to psychological changes. Similarly, the cognitive enhancement gymnastics program along with the music improved cognitive function and helped to reduce depression.

In the case of the S-ADL, the post average (3.15±2.87) was higher than preaverage (2.81±2.43). It is very meaningful that the evaluation of daily activity increased, albeit only slightly, after the cognitive enhancement gymnastics program was carried out. These results are consistent with the results that cognitive function, depression, and daily activities improved through physical activity, as confirmed in the studies that Kim and Kim (2012), and Lee and Kim (2003) conducted. The current study proves that physical activity is a very important factor that improves daily activities of elderly with dementia. Furthermore, the results suggest that it is urgent to develop a physical activity program that is tailored to the needs of the elderly with dementia (Han et al, 2014). In this respect, the development of a cognitive enhancement gymnastics program for the elderly with dementia is deemed timely.

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CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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