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Effect of Combined Anagram Training and Cardiac Exercise on Cognitive Function of the Elderly Living in Nursing Homes

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Abstract

Background: The decline in cognitive function occurs faster in the elderly who live in a nursing home than at home. Cognitive decline can interfere with the elderly carrying out their activities. The appropriate intervention is needed to improve the cognitive function of the elderly living in nursing homes.

Aim: The present study aimed to evaluate the effect of combined anagram training and cardiac exercise on cognitive function in the elderly living in nursing homes.

Method: A nonrandomized clinical trial study was conducted. Sixty participants in four nursing homes were included in a combined intervention group (n=30) to join cardiac exercise and anagram training three times a week for 12 weeks, and in a single intervention group to join anagram training (n=30). Cognitive function was evaluated using the Montreal Cognitive Assessment before and 12 weeks after the intervention. A within-group analysis (Wilcoxon test) and intergroup analysis (Mann-Whitney U test) were used to evaluate the effects of combination intervention on cognitive function.

Results: Although both groups demonstrated a significant global cognitive function and sub-cognitive function such as executive, attention, recall, and orientation cognitive function improvement before and after the intervention ($P<0.05$), the combined intervention group showed a much more significant improvement compared to the single intervention group ($P<0,05$), except for the orientation cognitive function ($P=0.674$).

Implications for Practice: The combination of anagram and cardiac exercise could be used as an intervention to improve cognitive function in elderly living in nursing homes.

Keywords: Anagram, Cardiac exercise, Cognitive function, Elderly, Nursing home

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Introduction

The elderly population in the world is increasing every year (1). As people age, their cognitive function declines (2,3). Globally, around 5.1%-41% of the elderly have cognitive function decline (1). Cognitive function decline is among the common problems in the elderly population. However, not all cognitive functions decline with age (3). The decline in cognitive function in the elderly can be shown by the inability to concentrate, think, and remember (4). Aging causes low efficiency of the brain's neural transmission resulting in slowing down of information processing, loss of information during transmission, reduced accumulation of new information, and retrieval of information from memory (3,4).

Living in a nursing home may lead to experiencing a cognitive decline in the elderly (5). Cognitive function decline is found to occur faster in the elderly who live in nursing home than at home (6). The cognitive changes in the elderly’s mind involve the presence of brain-derivative neurotrophic factors (BDNF) and dopamine (7–14). The brain-derivative neurotrophic factor regulates the cognitive function under normal and/or pathological conditions related to learning and memory (13). There is a decrease in BDNF of the elderly with cognitive impairment (14). Dopamine is one of the neurotransmitters in the brain that has a role in cognitive function (15). Dopamine regulates six cognitive skills that are important to human languages and thinking, such as motor planning, working memory, cognitive flexibility, abstract reasoning, temporal analysis/sequencing, and generativity (16).

Anagram training is one of the cognitive training interventions (17). Cognitive interventions are believed to improve cognitive function, such as attention, concentration, or memory (17). Although these interventions may be applied to the elderly, their effectiveness remains unclear. The cognitive intervention consists of cognitive training, cognitive rehabilitation, and cognitive stimulation (18, 19). Cognitive training and stimulation interventions may improve cognitive function better than cognitive rehabilitation in the elderly (20). However, the current systematic review and meta-analysis study results show that the cognitive interventions still show a minimal effect on the global cognitive function of the patients with mild cognitive impairments (21), and there is no effect on the global cognition of the patients with cognitive decline (22). Cognitive interventions (e.g., brain gym and exergame) in the elderly are not proven to improve cognitive function in the elderly (23, 24); while memory anagram therapy has been shown to improve the cognitive function of the elderly (17). Several recent studies have shown that a person performs cognitive mechanisms in the form of analytical problem solving on anagram (25,26), where the brain plays a key role in the mechanism (27,28). Physical exercise is also highly recommended in the elderly (29). Moderate intensity aerobic and resistance exercise proved to be superior to high intensity aerobic for the enhancement of older individuals’ executive cognitive function (29). The design of physical exercise needs to be adjusted to the condition of the elderly.

A cross-sectional study showed that combination of high physical activity and high cognitive activity or high physical activity and low cognitive activity or low physical activity and high cognitive activity improved cognitive impairment better than low physical activity and low cognitive activity in the elderly (30). A meta-analysis study revealed that a combination of physical exercise and cognitive intervention more positively affected mild cognitive impaired elderly on global, memory and executive function than single cognitive intervention (31). However, another meta-analysis of combined intervention based on virtual reality showed no effect on memory and executive function (32). It is important to know the effect of combined intervention on all cognitive functions, such as naming, language, abstraction, attention, and orientation, not only the effect on global cognitive function, executive, and memory cognitive functions. This study will evaluate the combination of anagram training and cardiac exercise on cognitive function such as global and all domain cognitive function in the elderly living in nursing homes. We hypothesized that a combination of anagram training and cardiac exercise was expected to improve the global cognitive function and domain of the cognitive function.

Methods

This nonrandomized trial study was conducted based on a pretest-posttest control group design from January 2021 until January 2022. Sixty elderly participants living in nursing homes in West Java, Indonesia, were participated and divided into a combined intervention group (n=30) and single

intervention group (n=30) according to the nursing home they lived in, using the convenience sampling method. The sample size was estimated based on the study by Park et al. (33). We estimated that a minimum of 30 participants in each group would provide 80% power to detect a score difference in the scale = 1.7 with ά = 0.05, allowing a 10% dropout rate. The inclusion criteria were being able to perform physical activity and being aged from 60 to 90 years. The exclusion criteria were severe dementia, Alzheimer's, depression, and mental disorders.
Cognitive function was evaluated using the Montreal Cognitive Assessment (Mo-CA), a reliable (inter-rater reliability=0.96) and valid (Cronbach's alpha=0.79) screening tool that assesses various domains of cognition, including attention, executive function, memory, language, visuospatial skills, conceptualization, calculation, and orientation (34). The total Mo-CA score range was 0-30. The Mo-CA score was measured by a researcher blinded to the study.
The participants in the single intervention group were given an anagram cognitive training three times a week for 12 weeks. The combined intervention group was given a cardiac exercise that has been developed by the Indonesian Healthy Heart Foundation and anagram cognitive training. The cardiac exercise intervention was consistent with the level and physical structure of the studied elderly. The intervention group together performed combined intervention three times a week for 12 weeks. The participants performed the cardiac exercise outdoors and the anagram training indoors. The participants performed two sets of the cardiac exercise with eight repetition per set under the supervision of a professional cardiac exercise trainer at 7.00 a.m. for 30 min (35) and continued with 15 min of anagram training (36). Movement and exercise duration have been adjusted to international exercise guidelines for the elderly to prevent damage or side effects of this cardiac exercise so that exercise goals could be achieved. Physical adaptation is required to implement the exercise; therefore, the elderly who could not perform physical activity were not included in the study.
The participants were asked to follow the movement of the trainer during the exercise. The participants performed the exercise with a regular rhythm. The exercise movements were in the form of walking and running in places interspersed with moving hands, feet, head, and body. In the cognitive anagram training, researchers gave ten new words that were commonly used daily every three weeks to the participants. Participants tried to arrange several new words from each given word as much as they could and wrote them in their logbooks. Researchers monitored the logbook of every cognitive training completed.
The SPSS software (version 23) was used to analyze the collected data. Categorical variables were reported as frequencies and percentages. The continuous variables were reported as mean and standard deviation (SD). The Shapiro-Wilk test was used to confirm the normal distribution. Since the randomization was not used in this research, we ensured that the two groups had the same baseline characteristics (homogeneous) to control the effect of confounding factors. A Wilcoxon and Mann-Whitney U test were used for continuous variables with a non-normal distribution, as well as Chi-Squared test and Fisher's exact test for qualitative variables. Independent t test was used for continuous variable with a normal distribution. A P-value of less than 0.05 was considered statistically significant.
The protocol was approved by the local Ethics Committee of the Faculty of Medicine Diponegoro University and was performed following the principles expressed in the Declaration of Helsinki. All participants gave written informed consent before participating in the study.

Results
Sixty elderly participated in this research from the beginning until the end (Figure 1). The combined intervention and single intervention groups were good matches for age, gender, education level, length of stay in the nursing home, hypertension history, anti-hypertensive drug, cognitive function, and BDNF and dopamine level (Table 1).
Table 2 presents that the combined intervention group showed a significant increase in the global cognitive function, executive, attention, recall, and orientation cognitive function by 8.44%, 17.81%, 7.26%, and 7.12%, respectively (P<0.05). The single intervention group also displayed a significant increase in the total cognitive function, executive cognitive function, attention cognitive function, recall cognitive function, and orientation cognitive function by 14.89%, 24.00%, 26.68%, and

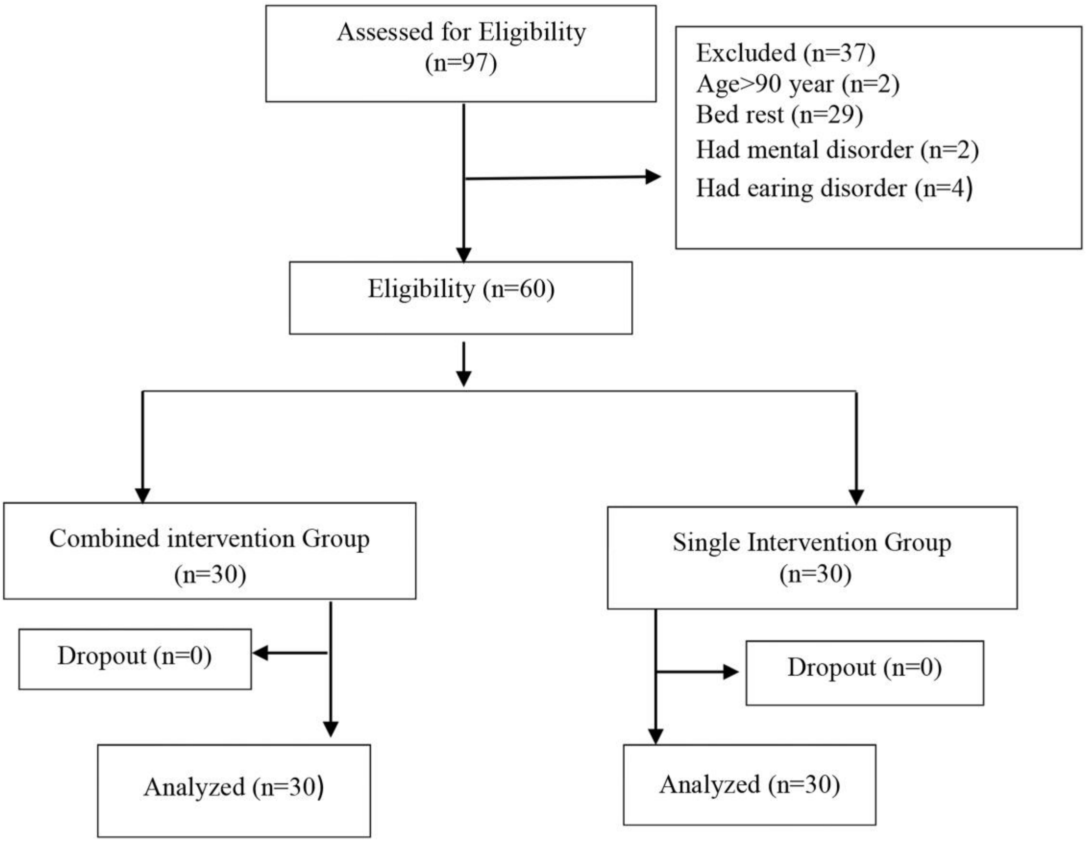

Figure 1. Consort diagram of the study

16.14%, respectively (P<0.05). Significant differences in changes in the global cognitive function, executive cognitive function, attention cognitive function, and recall cognitive function were observed between the groups (P<0.05). The effect size of the combined intervention on global cognitive function was calculated at 0.25, and the largest effect size of the cognitive function domain on attention function was 0.26.

Table 1. Characteristics of the participants

Characteristics	Combined Intervention Group	Single Intervention Group	P-value
Subject	30	30	
Age (year)	72.50±8.03	69.86±6.88	0,17[a]
Education			>0.99[b]
Low education	2(6.66)	3(10.00)	
High education	28(93.34)	27(90.00)	
Gender			0.40[c]
Male	8(26.66)	11(36.66)	
Female	22(73.34)	19(63.34)	
Hypertension			0.43[c]
Yes	12(40.00)	15(50.00)	
No	18(60.00)	15(50.00)	
Antihypertensive drugs			0.43[b]
Yes	12(40.00)	15(50.00)	
No	18(60.00)	15(50.00)	
Length of stay (year)	2.60±2.50	5±5.20	0.29[d]
Dopamine level (ng/ml)	92.10±44.86	80.40±31.50	0.24[a]
BDNF level (ng/ml)	42.86±11.07	42.86±12.12	>0.99[a]
Cognitive Function	24.03 ± .75	23.50 ± 2.43	0.59[d]

[a] Independent t test, [b] Fisher's exact test, [c] Chi-Square test, [d] Mann-Whitney U test

Table 2. Inter and intra group analysis on cognitive function

Cognitive Function	Stage of the Study	Combined Intervention Group	Single Intervention Group	P-value	Effect Size
Global Cognitive function	Pre	23.76±1.83	24.03±1.75		
	Post	27.30±1.64	26.06±1.38		
	P	<0.001[a]	<0.001[a]		
	Delta	3.54±1.43	2.03±1.24	<0.001[b]	0.25
Executive cognitive function	Pre	4.00±0.26	3.93±0.44		
	Post	4.96±0.18	4.63±0.55		
	P	<0.001[a]	<0.001[a]		
	Delta	0.96±0.18	0.70±0.53	0.01[b]	0.11
Naming cognitive function	Pre	2.93±0.25	3.00±0.00		
	Post	2.96±0.18	3.00±0.00		
	P	0.31[a]	>0.99[a]		
	Delta	0.03±0.18	0.00±0.00	0.31[b]	0.02
Attention cognitive function	Pre	3.86±0.73	4.13±0.43		
	Post	4.90±0.71	4.43±0.56		
	P	<0.001[a]	0.007[a]		
	Delta	1.03±0.76	0.30±0.53	<0.001[b]	0.26
Language cognitive function	Pre	2.90±0.30	2.94±0.25		
	Post	2.96±0.18	3.00±0.00		
	P	0.15[a]	0.15[a]		
	Delta	0.06±0.25	0.06±0.25	>0.99[b]	0.00
Abstraction cognitive function	Pre	1.96±0.18	2.00±0.00		
	Post	2.00±0.00	2.00±0.00		
	P	0.31[a]	>0.99[a]		
	Delta	0.04±0.18	0.00±0.00	0.31[b]	0.02
Recall cognitive function	Pre	3.53±0.50	3.60±0.82		
	Post	4.10±0.30	3.86±0.50		
	P	<0.001[a]	0.01[a]		
	Delta	0.57±0.50	0.26±0.52	0.01[b]	0.10
Orientation cognitive function	Pre	4.56±0.72	4.36±0.61		
	Post	5.26±0.69	5.16±053		
	P	<0.001[a]	<0.001[a]		
	Delta	0.70±0.79	0.80±0.61	0.67[b]	0.002

[a]Wilcoxon test, [b]Mann-Whitney test

Discussion

The elderly were examined at the global cognitive function and cognitive domain, such as memory, language, executive functions, visuospatial skills, calculation, abstraction, attention, concentration, and orientation by the Mo-CA instrument (37). It was found that the mean Mo-CA score of global cognitive function of the elderly in both groups before the intervention was below 26, and no difference in cognitive function level between groups was observed. The cognitive function of the elderly in both groups was included in a mild cognitive function decline.

The cognitive function decline in the elderly can occur due to the decrease in the level of BDNF and dopamine, which is essential in modulating cognitive function and maintaining the number of brain cells that play a role in cognitive function. However, no differences was observed in BDNF and dopamine levels before the intervention between groups in the present research.

It is concluded that the single interventions only in the form of anagram training could significantly improve global cognitive function, executive, attention, recall, and orientation as measured by Mo-CA. According to the results of systematic review and meta-analysis studies, cognitive intervention can improve global cognitive function (21). Cognitive interventions in this study were carried out in the form of cognitive training anagrams. In this anagram cognitive training, the participants were trained to think, remember, and make decisions. They were given several words using the language that they used daily in the group, then they arranged several words using as much as they could. The cognitive intervention was adjusted with the sociodemographic of the elderly to increase the effectiveness of the intervention on cognitive function (38). According to a previous study, the completion of an anagram task given to the elderly is positively correlated with a cognitive function performance (39).

The present study showed that the combination of anagram cognitive training and cardiac exercise could significantly improve the global cognitive function, executive, attention, recall, and orientation as measured by Mo-CA. This study added one intervention to the elderly by cardiac exercise. The combined intervention group performed anagram training after the cardiac exercise. The elderly performed the cardiac exercise, which is included in moderate-intensity aerobic exercise. Moderate intensity aerobic is better than a high intensity aerobic for the enhancement of older individuals' executive cognitive function (29). The elderly in this group enjoyed performing these activities. Exciting activities can increase the number of meeting between the elderly and increase the tendency to do the activities (40). The activities that strongly encourage elderly participation are very important to hold because the participation of the elderly in these activities can improve their health (41).

However, only global cognitive function, executive, attention, and recall cognitive function were significantly higher in the combined intervention group than the anagram cognitive intervention. The higher improvement in the global cognitive function, executive, attention, and recall cognitive function are due to the combined effect of the cardiac exercise and anagram training. In line with a previous study, a combination of physical exercise and cognitive intervention in mild cognitive impairment elderly significantly improved global cognition than the control group, memory function than the physical exercise, and executive/attention function than the single physical exercise or single cognitive intervention (31).

Implications for practice

A combination of anagram training and cardiac exercise is effective in improving cognitive function in the elderly. This combination is recommended as an intervention for cognitive function decline in elderly living in nursing homes.

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Conflicts of interest

The authors declare that they have no conflict of interest.

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