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Meta-analysis

Meta-Analysis of the Effect of Cognitive Activity Exercise on Independence Ability in Post-Stroke Patients

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ABSTRACT

Background: A stroke is an attack on the brain that occurs when the blood supply to part of the brain is blocked so that part of the brain becomes damaged and dies because it does not get nutritional intake. Cognitive exercise activities can maintain optimal blood flow and improve the delivery of nutrients to the brain. The study aims to analyze the effect of cognitive exercise activity on the independence ability in post-stroke patients.
Subject and Method: The study was a meta-analysis with PICO as the following: Population: post-stroke patients. Intervention: cognitive exercise activity. Comparison: no cognitive exercise activity. Result: independence ability. The articles used in this study were obtained from three databases, namely Google Scholar, PubMed, and ScienceDirect. The keywords for searching for the articles were "cognitive exercise activity" AND "cognitive ability" AND "post-stroke". The included articles were full-text English versions with a randomized control trial study design from 2012 to 2022. The article selection was conducted using the PRISMA flow diagram. The articles were analyzed using the Review Manager 5.3 application.
Results: A total of 9 case studies from Europe (Oxford, Sweden, United Kingdom), South America (Brazil), North America (Texas, Jamaica), Asia (Korea), and Africa (Egypt) were selected for systematic review and meta-analysis. It was discovered that cognitive exercise activity of 0.36 units increased independence ability in post-stroke patients compared to not obtaining cognitive exercise activities. Result statistically (SMD = 0.36; 95% CI = 0.19 to 0.54; p <0.001).
Conclusion: Cognitive exercise activity increased independence ability in post-stroke patients

Keywords: cognitive exercise activity, cognitive ability, post-stroke.

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BACKGROUND

A stroke is an attack on the brain that occurs when the blood supply to part of the brain is blocked so that part of the brain becomes damaged and dies because it does not get nutritional intake. Stroke can cause prolonged brain damage, disability, or even death. There are two types of stroke, namely ischemic stroke and hemorrhagic stroke. Ischemic stroke occurs when a blood clot or other particles clog a blood vessel in the brain. The accumulation of fat on the walls of blood vessels called plaque can also cause blockages. Meanwhile, hemorrhagic stroke

occurs when a blood vessel in the brain ruptures. So that blood accumulates and damages the surrounding brain tissue (CDC, 2019).

According to data from the World Health Organization (WHO) the prevalence of stroke in 2018 rise by 7% to 10.9%. The number of stroke sufferers in Indonesia in 2013 amounted to 12.1 per mile, while in 2018 according to Riskesdas the number of stroke sufferers decrease by 10.9 per mile (Kemenkes, 2019). Basic Health Research (Riskesdas) in 2018, states that the prevalence of stroke in Indonesia is 12.1 per 1000 population, an increase compared to Riskesdas in 2013 which is 8.3%. Stroke is the cause of death in the majority of hospitals in Indonesia. The incidence of stroke has increased sharply in Indonesia by 14.5%. Even today, Indonesia is the country with the largest number of stroke patients in Asia.

Proper and quality rehabilitation can increase the opportunity for the best recovery for post-stroke patients. Stroke rehabilitation involves physical, occupational, speech and/or cognitive therapy (Kuriakose and Xiao, 2020). Physical activity and moderate or high-intensity exercise are recommended as part of comprehensive rehabilitation in the chronic phase after stroke (Gunnes et al., 2019).

Cognitive activity is a form of non-pharmacological therapy that is very important to do to improve memory and concentration and reduce psychological disorders such as depression, anxiety, agitation, delusions, hallucinations, and insomnia.

Furthermore, the involvement of stimulation of cognitive functions on an ongoing basis causes the myelination of neurons or at least decreases the speed of demyelination which greatly contributes to the quality of life, independence, and overall functional abilities. Providing stimulation/ cognitive skill exercise are claimed to at least decrease the speed of demyelination of neurons so that a decline in cognitive function can be prevented. Cognitive skills exercises in the form of games are exercises that cover several aspects of cognitive functions such as memory, attention, and executive functions and are fun and very flexible activities and show meaningful results in improving the cognitive function of chronic post-stroke patients with mild cognitive impairment (Marannu, 2020). The study aims to analyze the effect of cognitive exercise activity on independence ability in post-stroke patients.

SUBJECTS AND METHOD

1. Study Design

The study was a Systematic and meta-analysis study. The articles used in this study were obtained from several databases, namely Google Scholar, PubMed, and Science Direct between 2012 and 2021. The article selection was conducted using PRISMA flowchart. The keywords for searching for articles were "cognitive exercise activity" AND "cognitive ability" AND "post-stroke".

2. Steps in Conducting Meta-Analysis

Meta-analysis was conducted through five steps, as follow:

a. Defining the research questions with PICO (Population, Intervention, Comparisson, Outcome) form.
b. Searching for primary study articles from various electronic databases such as Google Scholar, PubMed, Cochrane, Scopus and Science Direct as well as non-electronic.
c. Conducting screening and Critical Appraisal toward the primary studies articles.
d. Conducting data extraction and synthesizing the effect estimates into RevMan 5.3.
e. Interpreting and making conclusion.

3. Inclusion Criteria and Exclusion Criteria

The inclusion criteria in the study were: full-text article with randomized control trial

design, the study subject was post-stroke patients, the study results were the independence ability, multivariate analysis with Standardized mean difference (Mean; SD) to measure the estimated effect.

The exclusion criteria in this study were articles published in non-English languages, the reported statistical results in the form of bivariate analysis, and articles published before the year 2012.

4. Study Variables

The independent variables is Cognitive Exercise Activity and the dependent variable is Independence ability

5. Operational Definition of Variables

Cognitive Exercise Activity is to maintain optimal blood flow and increase the delivery of nutrients to the brain.

Independence ability is a process of processing sensory inputs to be perfectly transformed, processed, and stored for interneurons relationship.

6. Study Instrument

This study is guided by the PRISMA flow diagram and assessment of the quality of research articles using the critical appraisal tools randomized controlled trial (RCT) published by CEBM University of Oxford.

The following are indicators in critical appraisal:

1. Was the sampling for the treatment carried out at random, which includes methods and methods?
2. Does the research use the same group?
3. Apart from the allocated treatments/interventions, were the intervention groups the same?
4. Were all samples included in the study recorded? Were they analyzed in randomized groups?
5. Are objective measures or research participants applied a 'blinding' system to which interventions are being accepted? The study is ideal when using 'double blinded'?
6. How big is the effect of exposure?
7. How accurate is the estimate of the effect of the exposure given?

7. Data Analysis

The collected articles are processed using the Review Manager application (RevMan 5.3). Data processing is carried out using the continuous method. This method was used to analyze the effect size or standardized mean difference in bivariate data of two groups that had been controlled for confounding factors by randomization. The results of the systematic study and meta-analysis are presented in the form of forest plots and funnel plots.

RESULTS

The article search process was conducted through several journal databases including Google Scholar, Pubmed, and Science Direct. The review process of related articles can be seen in the PRISMA flow chart in figure 1. Studies related to cognitive exercise activity towards cognitive exercises consisting of 9 articles from the initial search process that yielded 2,842 articles, after the removal process, 573 published articles met the requirements for further full-text review. A total of 9 articles that met the quality assessment were included in the quantitative synthesis using meta-analysis. It can be seen in Figure 2 that the study article comes from 5 continents namely Europe (Sweden and UK), Asia (South Korea), South America (Brazil), Africa (Egypt) and North America (Jamaica and Texas). In table 2, researchers assessed the quality of the studies using critical appraisal tools randomized controlled trial (RCT) published by CEBM University Of Oxford 2014:

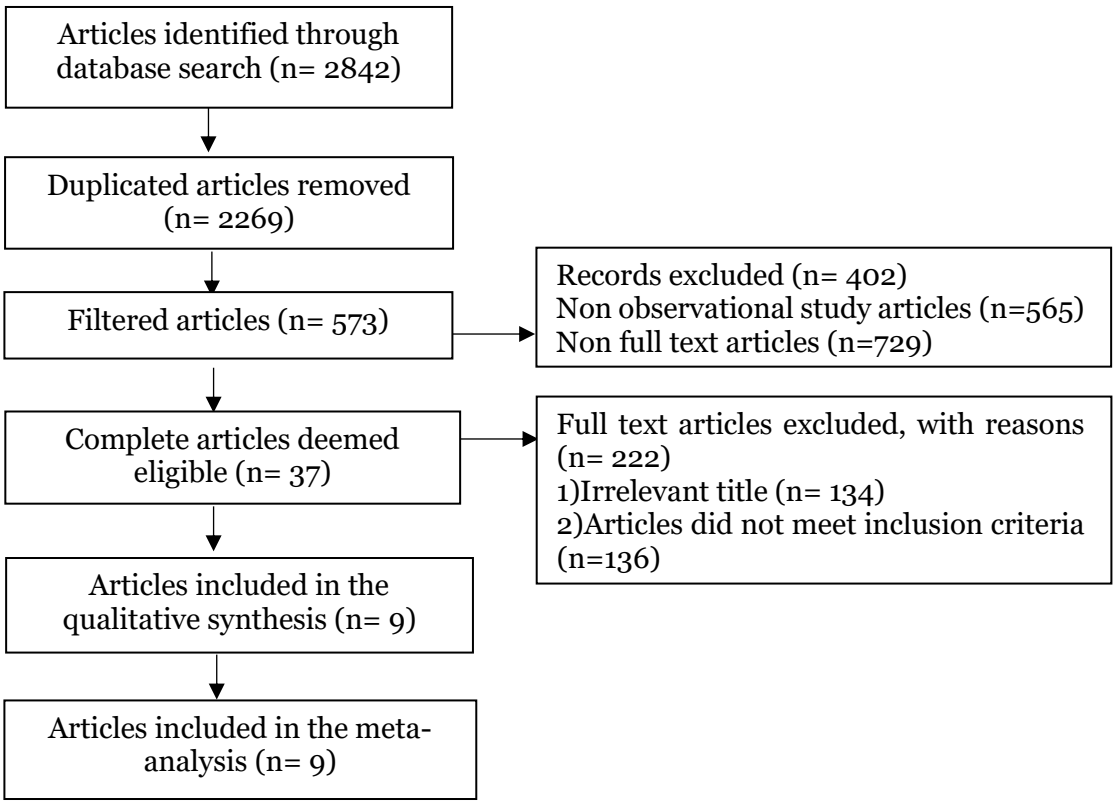

Figure 1. PRISMA Flow Diagram

Figure 2. Map of the research locations The Effectiveness of Acupucture in Reducing Pain and Improving Quality of Life in Patients with Low Back Pain

Table 1. Descriptions of primary studies included to meta-analysis of the effect of cognitive activity exercise on independence ability

Authors (Years)	Countries	Study Design	Sample		P Population	I Intervention	C Comparison	O Outcome	Mean (SD)	
			Experiment	Control					Experiment	Control
Kim (2017)	South Korea	RCT	14	15	Post-stroke patients with cognitive functions disorder	Cognitive Activity Exercise	no cognitive exercise activity	Improved Independence Ability	23.42 (6.85)	22.3 (4.97)
Tamawy et al. (2014)	Egypt	RCT	16	15	A number of post-stroke patients with several levels of disorder	Cognitive Activity Exercise	no cognitive exercise activity	Improved Independence Ability	81.07 (6.15)	75.93 (4.9)
Meester et al. (2018)	UK	RCT	26	24	Post-stroke patients	Cognitive Activity Exercise	no cognitive exercise activity	Improved Independence Ability	12.61 (0.82)	12.37 (0.86)
Moore et al. (2015)	UK	RCT	20	20	More than 6 months post-stroke patients of over 50 years of age.	Cognitive Activity Exercise	no cognitive exercise activity	Improved Independence Ability	92 (5.0)	91 (8.0)
Vahlberg et al. (2020)	Sweden	RCT	40	39	Post-stroke patients.	Cognitive Activity Exercise	no cognitive exercise activity	Improved Independence Ability	10.5 (2.4)	9.6 (1.9)
Vahlberg et al. (2016)	Sweden	RCT	33	34	Post-stroke patients aged 65-85 years	Cognitive Activity Exercise	no cognitive exercise activity	Improved Independence Ability	6.4 (5.0)	5.6 (4.7)
Swank et al. (2020)	Texas	RCT	37	36	Post-stroke patients.	Cognitive Activity Exercise	no cognitive exercise activity	Improved Independence Ability	26.4 (3.8)	25.2 (4.0)
Gordon et al. (2013)	Jamaica	RCT	64	64	6 – 24 months post-stroke patients over 40 years of age	Cognitive Activity Exercise	no cognitive exercise activity	Improved Independence Ability	39.1 (11.6)	32.5 (12.6)
Aguiar et al. (2020)	Brazil	RCT	11	11	Post-stroke patients with low physical activity	Cognitive Activity Exercise	no cognitive exercise activity	Improved Independence Ability	1.58 (0.41)	1.52 (0.78)

Table 2. Quality Assessment Results of Randomized Control Trial Studies of the Effect of Cognitive Activity Exercise on Independence Ability

No.	Questions of Checklist	Kim (2017)	Tamawy et al. (2014)	Meester et al. (2018)	Moore et al. (2015)	Vahlberg et al. (2020	Vahlberg et al. (2016)	Swank et al. (2020)	Gordon et al. (2013)	Aguiar et al. (2020)
1.	Does this study address a clear research focus?	1	1	1	1	1	1	1	1	1
2.	Is the Randomized Controlled Trial research method appropriate to answer the research question?	1	1	1	1	1	1	1	1	1
3.	Are there enough subjects in the study to establish that the findings did not occur by chance?	1	1	1	1	1	1	0	1	1
4.	Were subjects randomly allocated to the experimental and control groups?	1	1	1	1	1	1	1	1	1
5.	Are inclusion/exclusion criteria used?	1	0	1	1	0	1	1	1	1
6.	Were the two groups comparable at the start of the study?	1	1	0	1	1	1	1	1	1
7.	Were objective and unbiased outcome criteria used?	1	1	1	1	1	1	0	1	1
8.	Are objective and validated measurement methods used in measuring the results?	1	1	1	1	1	1	1	1	1
9.	Is effect size practically relevant?	1	1	1	1	1	1	1	1	1
10.	How precise is the estimate of the effect? Is there a confidence interval?	1	1	1	1	0	1	1	1	1
11.	Could there be confounding factors that have not been taken into account?	0	0	0	1	1	0	0	0	0
12.	Are the results applicable to your research?	1	1	1	1	1	1	1	1	1
	Total	11	11	10	12	10	11	11	11	11

Answer: 1=Yes, 0=No.

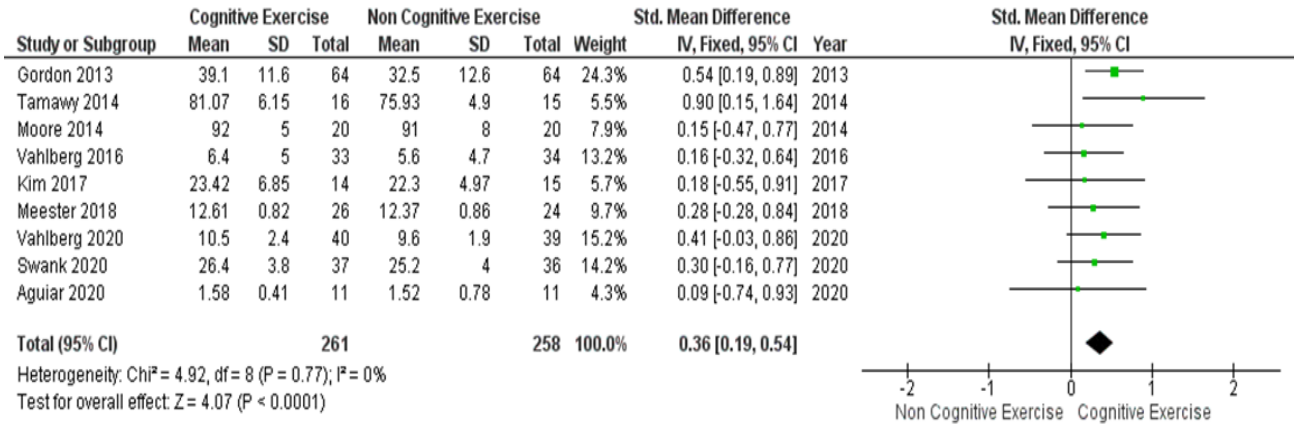

Figure 3. Forest Plot of the Effect of Cognitive Activity Exercise on Independence Ability

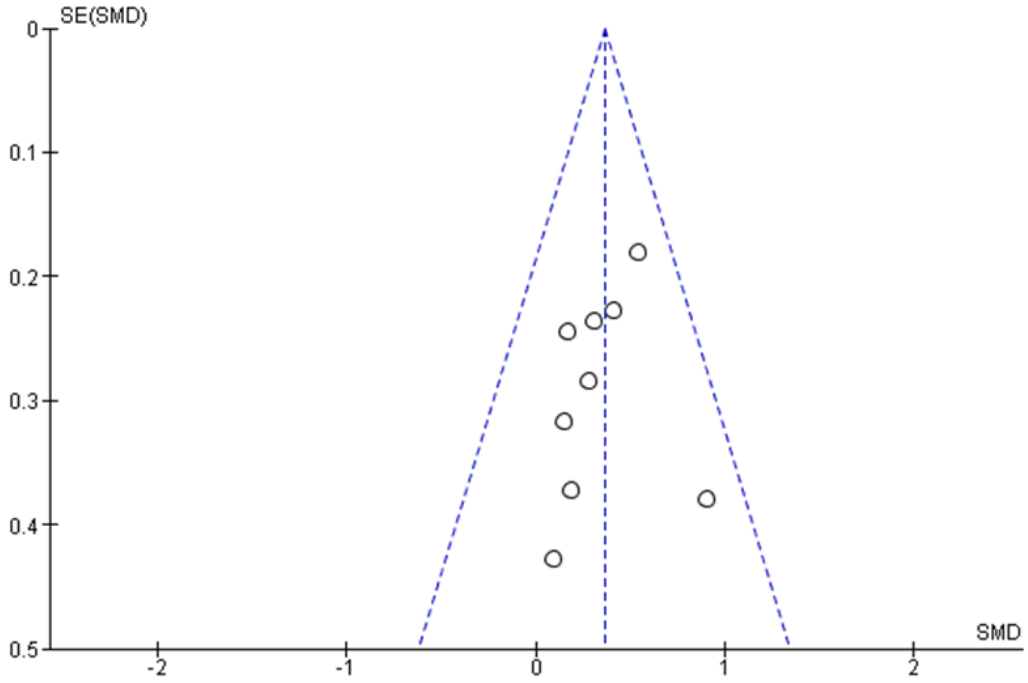

Figure 4. Funnel Plot of the Effect of Cognitive Activity Exercise on Independence Ability

a. Forest Plot

Based on the results of the forest plot (Figure 3) indicates that there was an effect of cognitive exercise activities on the improved independence ability of post-stroke patients. Post-stroke patients who obtained cognitive activity exercise on average had 0.36 units higher independence ability than not-obtaining cognitive exercise activity, and the effect was statistically significant (SMD = 0.36; 95% CI = 0.19 to 0.54; p <0.001). The heterogeneity of the study data showed I^2 = 0% so the data dissemination was declared homogeneous (fixed effect model).

b. Funnel plot

Based on figure 4. It indicates the distribution of estimated effects between studies was in an unsymmetrical meta-analysis. The

distribution of the estimated effect of cognitive activity exercise on the independence ability of post-stroke patients was more on the left side of the average vertical line of the estimated effect than on the right. Thus, the plot funnel indicated there was a publication bias. While the average estimated effect on forest plots was located on the left side of the vertical line of hypothesis 0, therefore the publication bias reduced the effect of cognitive activity exercise on the independence ability (under estimate).

DISCUSSION

The study was a systematic and meta-analysis study that discussed the theme of the effect of cognitive activity exercise on independence ability. This systematic study and meta-analysis used controlled research for confounding factors that can be referred from the inclusion criteria of the study, namely multivariate analysis, and the reported statistical results used Standardized mean difference (Mean; SD). The estimated effect of cognitive exercise activity on independence ability was processed using RevMan 5.3 with the generic inverse variance method.

The results of systematic studies and meta-analysis were presented in the form of forest plots and funnel plots. Forest plots provide an informed overview of each study examined in the meta-analysis, and the estimated overall results (Murti, 2018). Plot funnels visually indicate the number of variations (heterogeneity) (Akobeng, 2005 in Murti, 2018). The plot funnel indicates the correlation between the study effect size and the sample size of the various studies being studied, which can be measured in several different ways. A total of 9 primary studies that met the criteria regarding the effect of cognitive activity exercise on independence ability. 4 articles were from Europe, 1 from Africa, 1 from South America, 2 from North America and 1 from Asia. This study indicated that cognitive activity exercise could increase independence ability 0.36 times in post-stroke patients compared to without cognitive activity exercise and the results were statistically significant (SMD = 0.36; 95% CI = 0.19 to 0.54; p <0.001). The heterogeneity of the study data indicated I^2 = 0%, which means the data dissemination was stated as homogeneous (fixed effect model). Stroke is a condition that occurs when the blood supply to a part of the brain suddenly stops in the brain tissue, the lack of blood flow generates a series of biochemical reactions, which can damage or kill brain cells. The death of brain tissue can lead to the loss of functions controlled by the tissue. Stroke is the third leading cause of death in the United States and many industrialized countries in Europe (Taylor-Piliae et al., 2020). A stroke is an acute neurological deficit caused by impaired blood flow that arises suddenly with signs and symptoms corresponding to the focal region of the affected brain. The definition of ischemic stroke is the blockage of blood vessels that causes blood flow to the brain to stop partially or completely. It can be in the form of ischemia, embolism, spasms, or thrombus in the blood vessels of the brain. It generally occurs after resting for a long time or waking up (Kramer et al., 2019).

A study conducted by Moore et al., (2015) states that structured and educational exercises delivered by post-stroke patients generate improvements in metabolism, physical function, independence ability, and quality of life. The study protocol is considered feasible, and greater study must now be conducted to explore the long-term effects of structured exercise on stroke recurrence, cardiovascular health, and other independence ability improvement.

The result of a study by Swank et al., (2020) states that additional cognitive exercise activities through the Patient Directed Activity Program had a good impact on post-stroke patients. In the experimental group, patients completed more steps and reported a higher quality of life after 3 months of carrying out the activity treatment program. An increase in the number of steps in the first few years after a stroke is known to reduce the risk of new vascular events.

The result of a study by Tamawy et al., (2014) shows that aerobic exercise in post-ischemic stroke patients in the anterior circulation region significantly improves their cognitive function as measured by ACER. Aerobic exercise is added to the physiotherapy program rather than the ACER test because there is an improvement. The study can be related to the physiological effects of aerobic exercise on the brain due to the increased oxygenation of brain tissue, the speed of blood flow and cerebral metabolism, and homeostasis which in its turn improves independence abilities such as speed of information processing, motor learning, implicit memory, and cognitive function.

AUTHORS CONTRIBUTION

Lukman Aktovianta was the main researher who selected the topic, explored and collected data. Bhisma Murti and Rita Benya Adriani contributed to analyzing the data and reviewing study documents.

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CONFLICT OF INTEREST

There was no conflict of interest in this study.

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