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The Effect of Intervention Rehabilitation "Computer-Based Cognitive Training Program" to Improve Cognitive Skills of Children with ADHD: Literature Review

Fitrianti Umayroh Mahardika[1], Esti Yunitasari[2], Praba Diyan Rachmawati[3]
[1,2,3]Faculty of Nursing, Airlangga University Kampus C Surabaya, Indonesia

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Abstract

Attention Deficit Hyperactivity Disorder (ADHD) is a medical condition characterized by an inability to concentrate, hyperactivity, and impulsiveness. Children with ADHD tend to be careless, irritable, difficult to gather, difficult to carry out orders so it is important to treat this condition as early as possible. The purpose of this study was to analyze studies according to computer program-based cognitive rehabilitation interventions to improve the cognitive abilities of children with ADHD on empirical studies in the last five years. Journals or articles were obtained by searching in databases indexed by Scopus, PubMed, Science Direct, Garuda Portal using adequate keywords. The quality assessment of the study used inclusion and exclusion criteria. The framework used to conduct the review was PICOS and the inclusion criteria used English and Indonesian journals from 2015 to 2020. The data analysis and tabulation were carried out in articles or journals. Title, abstract, full text, and methodology were assessed to determine the eligibility of the article or journal. Researchers found 15 journals that match the inclusion and exclusion criteria, and passed the study selection and quality assessment. 7 journals discuss about training-based intervention programs and 8 journals discussed the game or game-based intervention programs. The 15 journals obtained came from four continents, Asia, America, Australia, and Europe. Computer-based intervention significantly improved the cognitive abilities of children with ADHD such as concentration skills, working memory, and academic learning outcomes. Modifications need to be made, among others, to facilitate parents who can not afford compatible facilities and infrastructure. In Indonesia, the modifications that are possibly made are the daily training program compared to video games.

✉Correspondence Address:
Airlangga University Kampus C Surabaya – East Java, Indonesia
Email: fitrianti.umayroh.mahardika-20m16@fkp.unair.amc.id
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INTRODUCTION

Attention Deficit Hyperactivity Disorder (ADHD) is a medical condition characterized by an inability to focus, hyperactivity, and impulsiveness which are usually more than their friends of the same age (Darmawati and Nuryani, 2020). Amalia in Darmawati argues that the characteristics of ADHD children tend to be clumsy, irritable, difficult to gather, difficult to carry out orders, often slip up when talking, convoluted, and like to interfere in other people's conversations (Darmawati and Nuryani, 2020). This disorder needs to be treated as early as possible to prevent long-term effects as adults. Based on this, the development of ADHD children is very important to treat immediately so they are able to do activities normally as their peers. Without specially-designed assistance, children with ADHD will encounter difficulty to learn optimally and develop their potential.

ADHD is one of the most common psychiatric conditions in children with a prevalence of around 5% (Bikic *et al.*, 2018). In the Data Diagnostic and Statistic Manual (DSM V), it is stated that the prevalence of ADHD children (especially children aged 12 years) ranges from 3-7%. *Attention Deficit Hyperactivity Disorder (* ADHD) in Indonesia is quite high as the number reached 26,4 %.

ADHD children are not unable to learn, but they are not ready to learn because the incidence and hyperactivity/impulsivity of ADHD children is more than normal for other children in their peers. D. Nass & Leventhall in Darmawati said that chemical and hormonal imbalances in the brain cause ADHD. Therefore, children with ADHD tend to be impulsive and difficult to organize planning because a part of the brain has disorders (Darmawati and Nuryani, 2020). Pharmacological treatments are effective for the core symptoms of ADHD, but their effect on cognition, especially executive function, is limited so it is important to find out other treatments (Bikic *et al.*, 2018).

One of the methods used to educate children with ADHD is the computer-based cognitive rehabilitation intervention method. First developed by Glisky *et al* in 1986 for memory training, these programs are a popular and accessible form of cognitive rehabilitation intervention and offer highly structured and standardized tasks that improve attention, concentration, memory, and perceptual-motor skills (Ko *et al.*, 2020). This computerized program is carried out by therapists who are experts in their fields. To minimize the negative impact that occurs in children with ADHD. The devices used in this program are various, such as game consoles, computers, and *tablet screens.*

According to Nurwahidin et al. 2016 Currently, technology information is growing rapidly, especially internet-based information technology which has a positive impact on many aspects in various fields, so the activities become more effective and efficient (fast and precise) (Kausar and Sukihananto, 2019). It is very possible to implement the internet-based information technology application of therapy in Indonesia such as educational games or *training*. There are various internet and computer-based interventions that are implemented in Indonesia and abroad, but on the other hand, there are not many literature studies that discuss computer-based interventions to reduce cognitive problems in children with cognitive disorders, so a deeper study is needed. Children's responses to a variety of cognitive training methods to find the most effective and feasible interventions to be implemented. Based on the phenomenon that has occurred, researchers are interested in conducting literature studies related to the effect of computer-based interventions on the cognitive abilities of children with cognitive impairments.

RESEARCH METHOD

A. Literature Searching Strategy

Literature searching in English was conducted on a *database* with high and moderate-quality criteria, that is *Scopus*, *PubMed, Science Direct,* and Garuda Portal. The searching process on Scopus was done by entering the keywords, "cognitive training" OR "cognitive therapy " AND "computer" AND "ADHD" AND "Child" OR "teenager" OR "toddler". The results specified in the last five years (2015-2020), open access to data in English. The number of journals after specified was 20 journals.

The searching process on PubMed by entering the keywords "cognitive training" OR "cognitive therapy" AND "computer" AND "ADHD" AND "Child" OR "teenager" OR "toddler". The results specified in the publication of the last five years (205-2020), open access to data in English. The number of journals after specified was 59 journals.

The searching process in Science Direct by entering the keywords "cognitive training" OR "cognitive therapy" AND "computer" AND

"ADHD" AND "Child" OR "teenager" OR "toddler". The results specified in the publication of the last five years (205-2020), open access to data in English. The number of journals after specified was 25 journals.

The searcing process in portal Garuda by entering the keyword "cognitive training" OR "cognitive therapy" AND "computer" AND "ADHD" AND "Child" OR "teenager" OR "toddler". The results specified in the publication of the last five years (205-2020), open-access data in Indonesian. The number of journals after specified was 2 journals.

All obtained journals screened for duplicates, titles, abstracts, and full text with an assessment of the quality of currency, relevance, authority, accuracy, and purpose. The researcher found 15 appropriate journals.

B. PICO Method

Criteria	Inclusion	Exclusion
Population	ADHD's children	Other than ADHD's children
Intervention	Intervension based on computer	Other than intervension based on computer
Comparators	No comparison	
Outcomes	Intervention with computer programs to improve cognitive function in ADHD	Other than intervention with computer programs to improve cognitive function in ADHD
Study design and publication type	Randomized control and trial	Other than RCT (Randomized Control and Trial)
Publication years	From 2015	until 2020
Language	English and Indonesian	Language other than English and Indonesian

RESEARCH RESULT

No.	Computer programs	Result
1.	Cogmed Working Memory *Training* (CWMT)	The combined treatment effect showed the overall pattern of the CWMT control group especially in adolescents with deficit working memory, behavioral regulation problems and global executive deficits as a biggest improvements.CWMT alone increased working memory when perfomances was measured with laboratory assesments of active maintenance of information. Behavior regulation and global executive functioning were most improved in the control CWMT.
2.	Computer Assisted Cognitive *Rehabilitation* (CACR)	CACR can result in improvements in attention equivalent to those of active stimulant medication. CACR participants, also, showed a trend of better maintenance of gains on sustained attention and response inhibition. Computer-assisted cognitive rehabilitation can positively impact practiced EFs, such as sustained attention, response inhibition, verbal and visuo-spatial STM (near transfer) as well as unpracticed EFs, such as complex nonverbal reasoning (far transfer).
3.	CCT (Computerized cognitive *training*) – Captains Log	Test result showed significantly improved overall TDE performance, with the effects being highly significant in the medicated group. Group showed post CCT improvements in writing and reading. And also, at school the children's grade showed improvements in math, with a 10 points increase in overall grade.
4.	Training Attention and Learning Initiative (TALI)	Children in the attention training showed grater improvement in selective attention performance. These improvements were maintained 3 months

		after training had ceased. Therefore as children showed increased in adaptive behaviour skills.
5.	Attention Processing Training program (APT)	The data showed that children significantly more pronounced improvement on cognitive test exploring attention, concentration, planning strategies, and visuo-spatial. APT improves in the global cognitive function and individual performance such as concentration, attention, processing speed, working memory and cognitive ability. And also data showed that patients improve their executive functioning, planning strategies, visuo spatial memory, and delayed recall performance.
6.	Multimedia tutorials programs : fairy tale	The implementation shows that the multimedia tutorial is effective and has a good effect on increasing the scores of ADHD children in school. It also shows that children are more interested in reading and remembering material using multimedia tutorials than just using textbook in order to increasing their score significantly.
7.	Computerized Cognitive Remediation Training (CCRT) (ACTIVATE™).	Consists of "Catch the ball," "Butterflies," and "What comes next." Children experienced an increase in the aspect of working memory after the intervention, which previously had a score of 4 during pre-WM increased to 14 post-WM. Participants in the cognitive training group improved performance mainly on the working memory NIH toolbox, which has similarities between subtests and the tasks involved on cognitive training games. after intervention, indicating that the ability to plan was improved in the intervention group as compared to the control group with a modest efect.
8.	CT (Cognitive Training) game - "Catch the ball," "Butterflies," and "What comes next."	In the active treatment period, 27 of 66 children (41%) showed at least a 30% reduction in parent ratings of ADHD symptoms. after intervention the CT group showed greater activation increases in response to increased attention demands in bilateral precuneus, right insula, bilateral associative visual cortex, and angular gyrus, and right middle temporal, precentral, postcentral, superior frontal, and middle frontal gyri.
9.	Wizard in Training - NF (Neurocognitive Function), WM (Working Memory) and IC game –	Intervention result on behaviour aspect showing a significant reduction in inattention, hyperactivity, attention problems and aggression. Children showed substantial improvement from the early to mid on the trained WM and IC tasks. The NF training tasks did not show across-session improvement according to level of difficulty.
10.	XBOX Kinect	Exergame interventions have shown that they are able to increase physical activity and motivation. no scientific findings are currently available from studies that have examined the effects of exergaming.
11.	Open resource game named Gcompris	The results of the pre-test and post-test of the use an open source-based educational game products in measuring visual responses, and initiative responses showed a positive change in value. This proves that the results of open sourced-based educational game products can be used to support learning activities in the ADHD (Attention Deficit Hyperactivity Disorder) childrens curriculum.
12.	SBT (Scientific Brain Traning) exercises and Tetris	We found both SBT and Tetris showed positive pre-post intra group beneficial effect on two outcomes of sustained attention with large effect. Tetris had a significant effect on spatial WM (Working Memory) on function regarding attention and working memory training. However SBT was orriginaly designed for adults and seems not to be suitable and interesting for adolescents in the used version. SBT was not well received by children participant, emphasizes the importance of investigating new interventions in feasibility trials before testing them in larger randomized and controlled trials.

The studies results will be reviewed from 15 journals were divided into several sections according to the location of their effect on the child's cognitive system. Various computer-based cognitive intervention programs on the *working memory* ability of ADHD children consist of the Cogmed RoboMemo Program which is part of the Computerized Working Memory Training (CWMT) as a video game trial involving racing robots, this study shows respondents working memory range have been increased (Steeger *et al.*, 2019).

Another program is the CCRT ACTIVATE™ which consists of six different games toward neurocognitive functions, such as working memory which includes the speed of understanding, attention, and category formation. In the form of a video game that includes a game of grouping objects, completing signs, remembering and arranging components (Rosa *et al.*, 2017). The same aspect of research conducted by (Farias *et al.*, 2017) suggests the Computerized Cognitive Training program is component of the Captain's Log *software* system, which was designed for children over 6 years old and adults who show improvement significance in memory, problem-solving, concentration, visual and auditory processing, and performance of self-discipline training.

While the influence of computer-based cognitive rehabilitation interventions on the *Attention* ability of ADHD children consists of APT (*Attention Processing Training*) programs that focus on aspects of continuous, selective attention consisting of a group of tasks as well as verbal and visual instructions starting from training the ability to concentrate on selective and alternative ways, forms of reading text, comprehension, and verbal performances that could impact global cognitive function (Simone *et al.*, 2018). The Attention and Learning Initiative (TALI) Training Program is a computerized training program that targets attention skills through four activities delivered on a touch screen tablet.

The effect of computer-based cognitive rehabilitation interventions on both aspects of *attention* and *working memory*, which consists of a combination program of Working Memory, Inhibitory Control, and neurofeedback training in children with AD / HD and subclinical AD / HD. After training, AD / HD symptom severity was reduced in AD / HD and subclinical groups based on interviews with parents (Johnstone *et al.*, 2017). Another intervention that shows significant improvements is XBOX Kinect, it is a device that projecting players and their movements on the screen using a camera. ADHD children and teens often play video games. Therefore, these *video games* are easy to implement at home and being investigated by a growing number of studies (Benzing and Schmidt, 2017).

There is also a CT Game which consists of three games, each with a difficulty level of 80–150. As a result of active intervention, 27 of 66 children (41%) showed at least a 30% reduction in ADHD symptoms (Wexler *et al.*, 2020).

Research conducted by (Umroh, Adi and Ulfa, 2019) Multimedia tutorial is an alternative learning media for ADHD children. These tutorial multimedia products as valid as a media of learning with the acquisition of the level of validity of subject matter experts by 95, 5 %, from 82.1875% of media experts, and expert practitioners of 92.5%.

DISCUSSION

The broad outline of the 15 interventions journals was divided into two main bases, that is interventions in the form of a daily training activity program (*Training Program*) and intervention with online educational *game* media. The Intervention Training program is a structured training program with material that had made to the child's preferences. There are 7 intervention interventions from 15 journals included in the base *training program* including *Cogmed Working Memory Training* (CWMT) for adolescents, PCACR and MED, a computer program called *Computerized Cognitive Training* (CCT), *Training Attention and Learning Initiative* (TALI) program, computerized rehabilitation called *Attention Processing Training program* (APT), as well as multimedia tutorials in the form of fairy tales.

Whereas for programs in the form of base games or games, there are 8 interventions, a computerized cognitive training program called ACTIVATE which consists of 3-6 games, 3 journals, CT game, and TAU training programs, "Mindwave" EEG deviced, XBOX *exergaming* Kinect, an open source-based educational game called Gcompris, and a *Scientific Brain Training* (SBT) program that contains various games.

In a study conducted by (Bikic *et al.*, 2018) After randomization, participants in the intervention group received individual user names and passwords via email and used them to access computer games

on a secure online web-based platform, which designed for this experiment. There was a big difference after intervention with an increase of 22%. Providing educational games is carried out with teacher supervision. (Wexler *et al.*, 2020) showed that Game CT was designed by BEW and developed and supported as a web-based application. The rest of the study more or less shows the same pattern of interventions to reduce ADHD problems. This cannot be separated from the computer-based rehabilitation intervention having the same basis in the application or intervention to children with ADHD.

Then (Steeger *et al.*, 2019) stated that the combined treatment effect showed the greatest overall pattern of improvement for the CWMT / BPT treatment control group, compared to the other three groups, in adolescents with WM deficits, behavior regulation problems, and global executive deficits. If it is based on 2 main bases, as *training programs* and educational games, in general, the improvement in various aspects is almost the same, especially the aspects of attention and memory work. Each intervention has its advantages and disadvantages. Because basically, it has basic use of intervention, that is computers, internet networks, and software, as well as verbal and visual instructions to be able to complete existing *tasks*.

RESEARCH LIMITATIONS

Research limitations weaknesses or obstacles faced by researchers when conducting research. The limitation in this *literature review* research method is most of the types of games are used only by the middle to upper-class economies because they use components or devices that are quite expensive and rarely owned by the wider community.

CONCLUSION

The forms of computer-based cognitive therapy based on reviewed journals are divided into 2 main *bases*, namely the form of *training* programs or training and online and offline educational games. Computer-based cognitive rehabilitation interventions have shown increased cognitive abilities in children with ADHD. The results of this study indicate that ADHD children are more interested in reading, remembering material, and playing with educational themes using multimedia tutorials or computer-based interventions in the form of *online* and *offline* educational games rather than just using textbooks. Intervention with computers or the internet significantly improves the cognitive abilities of children with ADHD, especially positive improvements in learning outcomes. Modifications need to be made, among others, to facilitate parents who do not have adequate facilities and infrastructure, which are assembled with tools and tools. In Indonesia, the modifications that can be made are the daily *training* program compared to video games.

SUGGESTIONS

The recommendation of this research si that it is hoped the policy makers in both health service and the government, in this case is Health Office can design and develop training programs by emphasizing various cognitive aspect in children with ADHD to facilitate parents who do not have adequate facilities and infrastructure, which are assembled with tools and tools. Especially in Indonesia, the modifications that can be made are the daily *training* program. The use of this programs in learning and therapy activities for ADHD children should be carried out through careful procedures to reduce the negative impact in the future.

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