

Research Paper

## Comparison of Effectiveness of Nutrition and C-CRT on Improving Working Memory in Children With ADHD



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## ABSTRACT

**Background** Improving memory is an indicator of treatment in children with Attention Deficit Hyperactivity Disorder (ADHD).

**Objective** The present study aimed to compare the effectiveness of Computerized Cognitive Rehabilitation Training (CCRT), nutrition supplementation intervention, and both combined on the improvement of Working Memory (WM) in children with ADHD.

**Methods** This was an experimental research with pre-test and post-test, follow-up and control group design. The statistical population included all of the elementary school girls of Tehran City, Iran. Using multilevel clustering, 66 children with ADHD were considered, of whom, 52 were selected for study participation and assigned into 4 experimental and control groups, each consisting of 13 individuals. SNAP-IV and clinical interviews were employed to diagnose ADHD. The Raven's Standard Progressive Matrices was conducted to measure the participants' intelligence level. The study participants were matched in age, Intelligence Quotient (IQ), and the gravity of ADHD symptoms. In group one, 22 sessions of 45-minutes of CCRT were performed using Captain's Log software. The second group received zinc, vitamin B6, and omega-3 for 4 months. In the third group, the first phase of the administration of zinc, vitamin B6, and omega-3 supplements was performed; after 15 sessions, CCRT was performed and obtained by the N-back test. Data were analyzed using repeated measures analysis of variance by SPSS.

**Findings** The obtained results represented the increased mean score of the improvement of WM in the intervention groups, compared to the control group. However, there was no significant difference in WM score between the intervention groups.

**Conclusion** CCRT and nutrition supplementation intervention improve WM in children with ADHD.

## Extended Abstract

### 1. Introduction

A

ttention Deficit Hyperactivity Disorder (ADHD) is the most prevalent neurobehavioral disorder among children. The clinical classification of ADHD is based on 6 signs

or more of the following symptoms: unrest, the loss of personal belongings, impulsivity, high risk behaviors, excessive speaking, forgetfulness, interrupting conversations, difficulty in understanding homework before the age of 12 years, which lasts for 4 months and will adversely affect the social, occupational, educational and family skills. The symptoms are not better explained by another mental disorder (e.g. mood disorder, anxiety disorder, and substance

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intoxication). The prevalence of Diagnostic and Statistical Manual of Mental Disorders, 5<sup>th</sup> Edition (DSM-V) related ADHD disorders is reported to be between 2% and 21% and is more prevalent in boys [1].

Barkley's theory focuses on one of the Executive Functions (EF) in general, with a clear application for ADHD. Barkley recognized a failure to inhibit responses as the cause of all other EF deficits observed in ADHD. EF is used to describe higher-order cognitive functions including inhibitory control and Working Memory (WM). WM is referred to the amount of short time memory engagement to support activity and skill [3, 4].

The nutritional ADHD evidence suggests that the mammalian brain is rich in unsaturated fatty acids that are not produced in the mammalian body and should be fed through dietary; the role of fatty acids is concerned with fluidity cortex and the function of vector. Among effective nutritional supplements, zinc is involved in the production of fatty acids and serotonin and is a dopamine inhibitor. Evidence suggests that adding omega-3, B vitamins, and iron to children's nutrition program will improve their cognitive functions and reduce ADHD-related behavioral symptoms [6, 7].

There are various treatments available for ADHD, including pharmacotherapy, behavioral therapy, cognitive behavioral therapy, parent-based interventions, Nutritional Therapy (NT), Cognitive Rehabilitation Training (CRT), group therapy and self-esteem enhancement [8]. C-CRT and NT are modern treatments with relatively acceptable empirical support [11,12].

Due to the controversial results from C-CRT and NT studies, which are at a beginning stage, it seems necessary to further explore these therapeutic areas. Therefore, in the present study, in addition to reviewing C-CRT and NT, the effectiveness of combination of these two treatments was investigated on the improvement of WM in children with ADHD [13].

## 2. Methods and Materials

An experimental design with a control group was used with three pre-tests, post-test and follow-up measurements. Raven's Progressive Matrices scores and the severity of disturbances were drawn in a coordinate axis. The students with similar scores of intelligence and the severity of ADHD were selected as quadruple blocks and randomly divided into 4 groups of 13 individuals (three interventional groups and one control group).

Age variables were homogeneous in all groups. In group one, 22 sessions of 45-minutes of C-CRT were performed using Captain's Log software. Zinc, B6 vitamin, and omega-3 were prescribed for 4 months in the second group. In the third group, the first phase of administering zinc, B6 vitamin and omega-3 supplements was performed, and after 15 sessions, C-CRT sessions were conducted. Data were collected using the N-back test. Data were analyzed using repeated measures Analysis of Variance (ANOVA) by SPSS.

## 3. Results

The obtained results represent the increased mean score on the improvement of WM in the intervention groups in comparison to control group. Although, there was no significant difference in WM scores between the intervention groups. Stability in Precision and promptitude in C-CRT group, NT group, and the combined group was observed in following. Additionally, findings suggest that the effect of time interaction is significant on precision and promptness (Table 1).

## 4. Conclusion

The obtained results indicate that WM in children with ADHD has been promoted in all experimental groups compared to the control group. In C-CRT group, the goal was to reinforce and rehabilitate cognitive components. These exercises provide prompt feedback, sequencing and locative calling, lead to learning new subjects, which improve cognitive abilities and self-control to achieve academic and cognitive success [23]. In addition, consis-

**Table 1.** The effect of group×time interaction on the dependent variables

Variable	Partial Eta Squared	P	F	ms	df	SS	Test Power
Precision	0.429	0.0001	12.01	620.55	3	3723.33	1
Promptness	0.66	0.0001	31.07	422365.59	3	1735609.48	1

tent with the effectiveness of NT in the present study, the positive effects of omega-3 have been reported in previous studies. Many studies have revealed the positive effects of vitamins and minerals such as iron and zinc on the growth and performance of neuropsychological skills. In explaining the effectiveness of NT, it can be argued that omega-3, vitamin B6 and zinc play roles in nerve growth and cognitive functions [24, 30].

The combined intervention had a significant effect on the improvement of WM, but did not have more efficacy than the other two experimental groups. Of course, the possible explanation is that the time of C-CRT and NT interventions in the combined group, was half the duration of each intervention proprietary, and the short period of time may have reduced the effectiveness of combined intervention. One of the limitations of this study is that the levels of supplementations in the blood of subjects were not measured before the onset of intervention to determine whether they were below the normal levels.

According to this study, it is recommended that C-CRT and NT be used along with pharmacological treatments. It is feasible to perform C-CRT on children. It can even be amusing with the help of family members at home, and may improve attention and WM in them. In addition to improving memory, the use of NT has other advantages, such as strengthening the immune system, promoting health and it is relatively less costly than other treatment methods [31]. Finally, future studies are recommended on investigating the nutritional interventions by measuring the serum levels of these supplementations before and after consumption.

## Ethical Considerations

### Compliance with ethical guidelines

The present research was approved by the Ethics Committee of Semnan University of Medical Sciences (code: IR.SEMUMS.REC.1397.008).

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### Authors' contributions

All authors contributed in designing, running, and writing all parts of the research.

## Conflict of interest

The authors declared no conflict of interest.