

Official Title

Effects of Structured Exercise Programs on Cognitive Function, Motor Skills, and Behavioral Outcomes in Children with Attention Deficit Hyperactivity Disorder

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1. Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is one of the most common neurodevelopmental disorders in childhood and is characterized by symptoms of inattention, hyperactivity, and impulsivity. In addition to behavioral symptoms, children with ADHD frequently experience impairments in executive functions, attention control, working memory, and motor coordination.

Recent research suggests that structured physical exercise programs may positively influence cognitive and motor functions in children with ADHD. Exercise-based interventions are thought to enhance neurocognitive functioning through increased arousal, improved neural efficiency, and enhanced executive control processes. Among these interventions, rhythm-based and cognitively demanding exercises have gained increasing attention.

Ginca Zumba is a movement-based exercise program that combines rhythmic movements, coordination, and aerobic activity, whereas Square Stepping Exercise (SSE) involves structured step patterns requiring visuospatial processing, motor planning, and executive control. Both exercise types may provide cognitive stimulation in addition to physical activity.

The aim of this study was to investigate the effects of Ginca Zumba and Square Stepping exercises on motor and cognitive functions in children with ADHD.

2. Methods

2.1 Study Design

This study was designed as a randomized controlled experimental trial with three parallel groups.

2.2 Participants

Children diagnosed with Attention Deficit Hyperactivity Disorder were recruited for the study. Participants were within the age range of **8-12** years and were diagnosed according to DSM criteria by a qualified clinician.

Inclusion criteria included:

- A clinical diagnosis of ADHD
- Being within the specified age range
- Ability to follow verbal instructions
- Ability to read and understand Turkish language
- Being under medication at least 2 months prior to the study

Exclusion criteria included:

- Presence of neurological, orthopedic, or psychiatric disorders other than ADHD
- Participation in regular structured exercise programs during the study period
- Inability to perform any physical activity

Written informed consent was obtained from parents or legal guardians prior to participation.

2.3 Randomization and Groups

Participants were randomly assigned to one of three groups:

1. **Gince Zumba Group (GZG)**
 2. **Square Stepping Exercise Group (SSEG)**
 3. **Control Group**
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2.4 Intervention Programs

Gince Zumba Group (GZG):

Participants in the Gince Zumba group participated in a structured exercise program for **8 weeks**, with **2 sessions per week**, each session lasting approximately **50 minutes**. The program included rhythmic movements, coordination tasks, and aerobic components appropriate for children.

Square Stepping Exercise Group (SSEG):

Participants in the Square Stepping Exercise group followed an **8-week** SSE program with **2 sessions per week**, each lasting **50 minutes**. The exercises involved progressively complex stepping patterns designed to challenge motor coordination and cognitive processing.

Control Group:

Participants in the control group did not participate in any regular physical activity program during the study period and continued their usual daily activities.

2.5 Outcome Measures

Assessments were conducted at baseline and after the 8-week intervention period.

Primary outcome measures included:

- Cognitive functions assessed using standardized neuropsychological tests (e.g., Stroop Test, Visual-Auditory Digit Span Test)

Secondary outcome measures included:

- Motor performance assessments (Blaze Pod Reaction Time Test)
 - Behavioral symptoms evaluated using parent-reported questionnaires (Conners Parent Rating Scale)
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2.6 Procedure

Baseline assessments were conducted prior to randomization. Following baseline measurements, participants were randomly assigned to one of the three groups. Exercise

interventions were conducted over an 8-week period. Post-intervention assessments were performed using the same measurement tools as at baseline.

2.7 Ethical Considerations

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Çukurova University Non-Interventional Clinical Research Ethics Committee (decision no: 127/64, dated November 4, 2022) and was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all parents or legal guardians before participation.

2.8 Statistical Analysis

A per-protocol analysis approach was used, and pre-test and post-test measurements were analyzed for all three groups. Statistical analyses were performed using SPSS software (IBM Corporation, Version 22, Armonk, NY, USA). One-way analysis of variance (ANOVA) and Pearson's chi-square test were used to analyze baseline demographic characteristics of the participants. To examine the primary outcome variables, a two-factor repeated measures analysis of variance (group \times time) with Bonferroni post hoc correction was applied. Within-group changes were analyzed using paired-samples t-tests. A p-value of less than 0.05 was considered statistically significant.

4. Results

Primary Outcomes

Cognitive Function

Cognitive function was assessed using the Stroop Test and the Visual-Auditory Digit Span Test. Changes from baseline to post-intervention scores were used to evaluate attention, executive functions, working memory, and cognitive processing speed. Both intervention groups demonstrated improvements in cognitive functions. The Gince Zumba group demonstrated greater gains in attention-related abilities, while the Square Stepping Exercise group showed more pronounced improvements in high-level cognitive functions."

Secondary Outcomes

Motor Performance

Motor performance was evaluated using the BlazePod Reaction Time Test. Changes in reaction time from baseline to post-intervention were analyzed. While both intervention groups exhibited significant improvements in motor performance relative to the control group, the enhancements were more pronounced in the Square Stepping Exercise group

Behavioral Symptoms

Behavioral outcomes were assessed using the Conners Parent Rating Scale. Changes in total and subscale scores from baseline to post-intervention were used to evaluate ADHD-related behavioral symptoms. Both intervention groups demonstrated significant reductions in ADHD-related behavioral symptoms relative to the control group and baseline measurements.

4. References

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