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Case Study

The effects of a home-based sensorimotor program on executive and motor functions in children with ADHD: a case series

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Abstract. [Purpose] The purpose of this study was to learn about the effects of a home-oriented program based on sensorimotor activities on executive and motor functions in children with ADHD. [Participants and Methods] In this study, a home-based sensorimotor program was conducted for two male children diagnosed with ADHD. The participants performed the program with their parents four times a week, for forty minutes each time, over a 12-week period. The participants'executive functions and gross motor skills were evaluated using the Children's Color Trails Test (CCTT) and the Bruininks-Oseretsky Test of Motor Proficiency-2 (BOT-2). [Results] After participating in the home-based sensorimotor program, the participants showed improvements in both their executive and motor functions. [Conclusion] This study confirmed that a home-based sensorimotor program was effective in improving executive and motor functions in children with ADHD. This conclusion suggests the need to develop various exercise programs that can relieve the symptoms of ADHD in children and improve their abilities to adapt at home or school.

Key words: ADHD, Home-based program, Executive function

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INTRODUCTION

Attention deficit hyperactivity disorder (ADHD) is a condition of attention deficit, hyperactivity, and impulsiveness that lasts for at least six months. It is a commonly appearing disorder in school-age children[1)]. Many studies explain that dysfunctions in the brain's prefrontal lobe and a deficiency in neurotransmitters account for the symptoms of ADHD. Since the prefrontal lobe is associated with such executive functions as judging, planning, and decision-making, dysfunctions in the prefrontal lobes of children with ADHD cause problems with their executive functions[2)]. Executive functions are developed in childhood and adolescence, and they control or manage children's cognition, behaviors, emotions, and social interactions. Children with impaired executive functions experience difficulties in performing behavioral interruption, compliance with rules, and social behaviors[3)]. In turn, these difficulties negatively affect their school performance and sociality. Moreover, children with ADHD exhibit developmental problems, including reduced motor skills in such areas as strength, equilibrium, coordination, and reaction time[4)]. The lowered levels of muscle tone, balance, and coordination in these children cause them to have unstable postures and reduced behavioral agility, which eventually affect their academic performance and peer relationships.

A number of previous studies have focused on medication and cognitive-behavioral therapy (CBT). However, CBT is not always effective in reducing the symptom of problem behavior, and it has a limitation in that it requires reinforcing factors for behavioral facilitation[5)]. Today, exercise therapy is emerging as an advantageous treatment for overcoming this limitation[6)]. Studies have reported that children's interest, amusement, and motivation are increased by exercise therapy[7)]. It also induces

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their spontaneous participation and is effective in relieving the symptoms of ADHD[8]. Therefore, the aim of the present study was to apply an exercise program in children with ADHD, which had been designed for regular implementation at home, not clinics, and to examine the effects of the program on the children's executive and motor functions.

PARTICIPANTS AND METHODS

This study involved two male children (aged seven and nine) who had been diagnosed with ADHD. Participant A was attending a kindergarten, and was participating in sensory integration therapy and speech therapy once a week. Participant B was attending an elementary school and was participating in sensory integration therapy once a week. The selection criteria were children who had low levels of attention and motor skills and agreed to participate in this study. All protocols were approved by the University of Hanseo. The study was conducted over a 12-week period between November 2017 and January 2018. As an intervention, a home-oriented program based on sensorimotor activities was run by the parents of each child at their homes on four afternoons each week, and each session lasted for 40 minutes. The program comprised nine tasks that participants usually find interesting: rolling on the floor, rocking in a rocking chair, balance activities such as walking a curb or standing on one foot, bouncing on a bed, small exercise on the trampoline, wrapping themselves up in towels or blankets, pushing against the wall, climbing or hanging on monkey bars, and wheelbarrow walks. Before starting the program, the therapist provided the children and parents with a training session in a treatment room so that they could practice each activity to skillfully perform during the program. Each participant was instructed to select five out of the nine tasks in the home-based program and perform each of them for about eight minutes, thereby completing all exercises within 40 minutes. The therapist then managed a steady and smooth implementation of the program by monitoring whether each participant completed his weekly activities. The Children's Color Trails Test (CCTT) 1 & 2, and the gross motor subtests of the Bruininks-Oseretsky Test of Motor Proficiency-2 (BOT-2) were used to evaluate the executive functions and motor skills of each participant before and after the intervention[9].

RESULTS

Both participants exhibited improvements in their executive and motor functions before and after the intervention. The results of the CCTT-1 & 2, which evaluate sequential processing skills, cognitive flexibility, and divided attention, showed improved scores in both participants after the intervention. The results for each participants were as follows: For participant A, the standard score for the CCTT-1 improved from 73 points (the fourth percentile) to 80 points (the 10th percentile) after the intervention. The number of errors in numerical sequence tasks also decreased from 4 times to 2 times after the intervention. The participant's mean score for the CCTT-2, which measures cognitive flexibility and divided attention, improved from 86 points (18th percentile) to 93 points (31st percentile) after the intervention. The number of numerical sequence errors and the near-miss score also dropped from 3 times to 1 time and from 4 times to 2 times, respectively, after the intervention. For participant B, the standard score for the CCTT-1 improved from 100 points (50th percentile) to 108 points (69th percentile) after the intervention. There was a reduction in the near-miss score from 1 time to 0 time. The participant's mean score for the CCTT-2 improved from 96 points (38th percentile) to 104 points (62nd percentile) after the intervention. After the intervention, there was a reduction in the number of color sequence errors from 2 times to 0 time. The near-miss score also declined from 2 times to 1 time. For participants, the BOT-2 gross motor composite scores were also confirmed to have improved after the intervention (Table 1). While the gross motor standard score and composite score of participant A showed low levels of performance at 44 points and 39 points (12th percentile), respectively, these scores were restored to average levels of 57 points and 48 points (42nd percentile), respectively, after the intervention. Participant B's BOT-2 scores also improved from a standard score of 43 points and a composite score of 38 points (12th percentile) before the intervention to a standard score of 55 points and a composite score of 47 points (38th percentile).

Table 1. Change in the gross motor ability of the participants (unit: score)

	Participant A		Participant B	
	Intervention			
	Pre	Post	Pre	Post
Gross motor subtests	Standard score		Standard score	
1. Running speed and agility	5	11	4	7
2. Balance	6	8	6	9
3. Bilateral coordination	17	20	19	22
4. Strength	16	18	14	17
Sum	44	57	43	55

DISCUSSION

This study investigated the effects of a home-based sensorimotor program on executive and motor functions in children with ADHD. As a result, after the intervention, improvements were confirmed in the executive and motors functions of the participants. This research finding agreed with that of a study in which exercise therapy was found to be effective in improving the executive and physical motor functions of children with ADHD[10, 11]. Some recent studies have reported that appropriate levels of aerobic exercises have positive effects on neurocognitive functions or behavioral control in children with ADHD[8, 9, 12]. Moreover, some studies suggested that the application of combined exercises including aerobic exercises in children with ADHD have positive effects on not only their executive functions (associated with their prefrontal lobes) but their psychological and physiological functions[3, 4]. Similarly, the present study implemented a home-based exercise program that suited the developmental levels of children with ADHD and confirmed its positive effects on their executive and motor functions. This study had a limitation in terms of generalizing its results, since it involved only two children with ADHD. However, the active adoption of exercise therapy in children with ADHD in educational settings will likely reduce the pattern of maladjustment experienced by children with ADHD in school or academic performance. In the future, therefore, various exercises programs should be developed for their application at home or school in conjunction with various measures for economic and policy support.

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Conflict of interest

None.

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