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The Effect of 8 Weeks of Gymnastic Exercises on Basic and Cognitive Skills in Children with Attention Deficit / Hyperactivity Disorder

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***Abstract*— Physical activity is used as a method in the treatment of children with motor and cognitive disorders. The aim of this study was to investigate the effect of 8 weeks of gymnastics training on basic and cognitive skills of children with attention deficit / hyperactivity disorder. The present single subject study is a research design in the form of post-test and pre-test. Case of study was a 5-year-old girl living in Karaj who suffered from attention deficit / hyperactivity disorder. The Ulrich test was used to measure motor skills and the London Tower test was used to measure cognitive skills. Exercise interventions include 8 weeks of gymnastic training. After performing the training protocol, the subject participated in the post-test. The results of the exercise showed that gymnastic exercises have improved the level of performance of the child in basic and cognitive skills. Planning according to the needs of the child improves the performance of children with attention deficit / hyperactivity disorder.**

Keywords*— *Ulrich test, London Tower test, basic skills, attention deficit

I. INTRODUCTION

Childhood is one of the most important stages of life in which a person's personality is formed and formed. Children in this period have differences in cognitive, behavioral, social and emotional skills. The presence of these differences, if not addressed in a timely manner, may lead to disorders in children. One of these disorders is a common disorder called Attention Deficit Hyperactivity Disorder (ADHD). The prevalence of this disorder in school-age children is reported to be 3 to 7% worldwide (1). According to Meyer et al. (2015), neural differences in the structure and function of the prefrontal cortex lead to impaired behavior control and inattention (2). These children have behavioral and cognitive characteristics such as inability to control motor skills, attention deficit, learning disability, aggression, academic problems, arousal, and motor restlessness (3, 4). Motor skills are especially important in school-age children; Because it is a prerequisite for the implementation of specific sports skills and affects the participation of individual social activities such as games and group sports (5). In

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general, research on children with ADHD shows that these children are at a lower level than their peers in the implementation of basic skills and fine and gross motor skills (6-9). Because this disorder leads to developmental delays in motor and cognitive areas, failure to progress to the implementation of basic skills will have direct and indirect consequences on the ability of individuals to perform skills related to specialized movements; so parents and families are looking for a way to treat this disorder. What is important about this disorder is that, a unique method in the treatment of this disorder has not been introduced and most of the therapeutic interventions performed due to concerns about the side effects of drugs have been cognitive-behavioral interventions (1). One of the effective methods of intervention has been physical and cognitive exercises on children with ADHD. The results of studies in this field have shown that physical exercise can improve the functional and cognitive deficits of children with attention deficit / hyperactivity disorder (10-12). In this regard, Klil-Drori and Hechtman (2020) in their research pointed to the positive effects of aerobic exercise on people with attention deficit / hyperactivity disorder (12). Ghorbanpour et al. (2013) believe that physical exercises are of special importance due to their two characteristics of movement and rhythm (13). In addition to being an effective way to improve basic motor skills, physical exercise also affects cognitive processes, attention, perception and the development of personal relationships and social skills (14). Akbari et al. (2009) evaluated the effect of 24 sessions of physical activity (local and indigenous play) on the development of positive basic skills (15). Draper et al. (2012) also concluded in their study that physical activity as a group affects the development of gross skills and cognitive skills in preschool children (16). One of the best ways to get rid of acne scars is to do gymnastics. Because gymnastics provides opportunities for physical awareness and individual abilities and body control, it can help improve weaknesses in children with ADHD.

Therefore, this study investigated the effect of 8 weeks of gymnastic exercises on basic and cognitive skills of children with attention deficit / hyperactivity disorder.

II. METHODOLOGY

The present study is a single-subject design. These plans include detailed, in-depth and individual study of subjects in different situations and environments. In these designs, the changes resulting from experimental interventions in relation to the individual are evaluated. In other words, in such schemes, the individual himself plays the role of both experimental subject and control subject. The purpose of such schemes is to determine the effectiveness of interventions in relation to a particular case. In some cases, such schemes are used that often not many people can be found in educational conditions (17). However, the statistical population of the present study includes all children aged 5 to 10 years in Alborz province who have attention deficit / hyperactivity disorder. According to the purpose of the study, a 5-year-old child with ADHD with an average intelligence score (95) living in Karaj was selected as the main subject using purposive sampling method. The degree of attention deficit in the child was determined after filling out the Connors 60 parent questionnaire. The validity of this questionnaire is 85% and its reliability is 91%. This questionnaire has 26 items and its total score varies from 26 to 104. If a child scores above 34, it indicates attention deficit disorder. The higher the score the greater disorder in the child (18).

In the post-test stage, the Coarse Motor Development Test (TGMD-3) was used to assess basic skills. This test assesses 13 motor skills, which are divided into two subtests, movement skills and ball skills (manipulation). Moving skills measured include: running, trotting, rocking, stepping, horizontal jumping and sliding, and ball skills include: hitting a stationary ball with both hands, one-handed forehand, on site dribble, Receive, hit with the foot, throw from above the head and throw from below with the hand. The scoring method is such that if the child meets that criterion or not, a score of one and zero is considered, respectively.

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The final score of the basic skill is obtained by combining the standard scores of the sub-test of movement and control of the object (ball). Ulrich and Webster reported the mean reliability coefficient of the displacement skill test as 0.97, the reliability coefficient of the ball skill test as 0.95, and the overall reliability coefficient of the gross motor skills test as 0.97 (19). Also, at this stage, the London Tower test was used to assess cognitive skills. The test was performed using the London Tower Test software of the Sina Cognitive Behavioral Sciences Research Institute. In this test, you have to make the sample shape by moving the colored beads (green, blue and red) and placing them in the right place with the least necessary movements. The subject was told that you would be given 12 problems and that you would have to correct the sample shape with the least amount of movement. The scoring method in this test is such that the person will be given a score based on his / her efforts in solving the problem. Thus, when a problem is solved in the first attempt, it scores 3, when it solves in the second attempt, it scores 2, when it solves in the third attempt, it scores 1, and when three attempts fail, it scores zero. It becomes. The maximum score in this test is 36. Also delay time or design time (includes the number of moments that are calculated for a person from presenting a pattern of an issue to the beginning of the first move in an attempt), test time (total moments from the beginning of the first move in an attempt to completing moves in the same attempt) The total test time (total delay time and test time) and the total result (total score) are accurately calculated by the computer.

After the pre-test, the child practiced gymnastic skills for 8 weeks and 3 sessions per week. Each training session was dedicated to three parts of warm-up (10-15 minutes), main exercise (35-40 minutes) and cooling (10 minutes). The exercises were initially selected from simple gymnastic movements and were mostly aimed at familiarizing the child with the principles of gymnastics. As time passes and the child progresses in the initial exercises and corrects the movements, the intensity and complexity of the exercises increase. The progress of the exercises was from stationary movements to jumping and jumping movements. There was also a 30-second rest period between each exercise and the next. After the exercises, in the post-test phase, the subject was re-evaluated in basic skills (displacement and manipulation) and cognitive skills.

Table1. Exercises used in the 8-week training course

Exercise session	Activity
First session	Skills of standing, walking and running correctly, strengthening hand muscles
second session	Consecutive pair jumping skills and long jump
third session	Flexibility skills, rabbit jumping and angle sitting
Fourth and fifth sessions	Proper standing skills, cradle and candle introduction
Sixth Session	Body and slide or fern integration skills
Seventh session	Swimming skills, throwing legs back and forth and jumping fish
Eighth session	Angel skills on the knee, open leg gesture and hand bending swimming
Ninth and tenth sessions	Arched waist skills with open legs, balance preparations and scapular flexibility
Eleventh and twelfth sessions	Candle skills, rocking cradle and strengthening abdominal and back muscles
Thirteenth session	Arched waist skills with open legs, balance and flexibility
Fourteenth and fifteenth sessions	Straight leg cradle skills, back arch and squat
Sixteenth and seventeenth sessions	Body rotation skills: back, leg open and sitting angle
Eighteenth and nineteenth sessions	Front rolling, bridge and wall balancing skills
Twentieth, twenty-first and twenty-second sessions	Skills of balancing, throwing legs and carousel
Twenty-third and twenty-fourth sessions	Tripod and angel balance skills

In order to analyze the data, the method of eye analysis, effect size was used. The effect size was also obtained from Cohen's d method. This effect size is based on mean and standard deviation in pre-test and post-test.

III. RESULTS

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The displacement subscale in motor skills increased after 8 weeks of gymnastics training. The child's raw scores on movement skills in the pre-test stage were 24 and after performing gymnastic exercises in the post-test stage, it reached 38, which indicates the effect of gymnastics exercises on movement skills.

Examination of the child's scores in the pre-test and post-test stages shows that in all variables related to the displacement subscale, except for the hiccup variable, positive changes have taken place after eight weeks of gymnastic training.

Also, the study of scores shows that the child's raw scores in the ball skill subscale have changed positively in motor skills after gymnastic exercises. The child's raw scores on manipulation skills at the pre-test stage were 22, and after gymnastics this number changed to 32.

Examining the child's scores on ball skills shows that gymnastic exercises have been able to improve the other subscales except for the two subscales of throwing from below and dribbling. However, this performance improvement is less than that of mobility skills.

The results of repeated measurements of mean changes in mean scores in the pre-test and post-test stages (Table 1) indicate the magnitude of the high effect of gymnastic exercises on motor function of a child with attention deficit / hyperactivity disorder.

Gymnastics also improves test execution time and reduces test error in children with ADHD.

Table1. Results of repeated measurements of the subject's motor abilities based on raw scores

Variable	pre-test	post-test	Cohen's d	effect size (Interpret)
Movement skills	4 ± 1.2	6.3 ± 5.48	1.069	very high
Ball skills	3.16 ± 2.16	4.33 ± 1.49	0.78	high

IV. DISCUSSION

The aim of this study was to investigate the effect of 8 weeks of gymnastics training on basic and cognitive skills of children with attention deficit / hyperactivity disorder. The important point in this study is that the study of physical exercise on people with ADHD has received less attention individually. As mentioned in the research results section, eight weeks of gymnastic exercise has a beneficial effect on motor skills of children with attention deficit / hyperactivity disorder. These findings are consistent with the results of Amouzadeh et al. (2015), Eslami et al. (1398), Etnier (2010) and Verret et al. (2016), all of which emphasize the positive effect of physical activity on the development of motor skills (23-20). These results contradict the theory of maturity, which states that the growth process is controlled by genetic factors (24) and emphasize the views of scientists who believe that physical activity leads to child development (25). Also, the findings of the present study are in contradiction with the findings of Williams (2005) (26). Williams found in his research that basic skills develop only on the basis of age and maturity, and that participation in physical activity has no effect on the development of basic skills. Contradictory results of research in this field can have different reasons. One of these reasons is the type of exercise program. Sometimes exercise programs are not designed and implemented to suit the child's needs, which reduces the effectiveness of exercise programs on the child's basic skills. In the present study, by designing exercises based on the needs of a child with ADHD, performance improvement in basic skills is observed after eight weeks of gymnastic training.

On the other hand, due to the lack of space and the high cost of sports classes, most children do not have enough time to engage in physical activity, which can lead to new movement problems or exacerbate existing problems in children. Based on the results of the present study, it can be said that participating in a gymnastics training program that is tailored to the needs of the child leads to experiencing opportunities to increase body awareness and individual abilities and more control over body

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organs, which ultimately leads to improved performance in basic skills (27).

Examination of the average scores obtained in the subscales of manipulation (ball skill) and post-test displacement shows that gymnastic exercises had a greater effect on displacement skills. These results are consistent with Akbari (2013) research (27). One of the reasons for the effectiveness of gymnastic exercises is the greater use of movement skills during these exercises. In the other words, when practicing gymnastic skills, more movement skills are used which has led to the further development of this skill.

On the other hand, the study of the average performance of post-test manipulation skills showed that this subscale was less advanced than the displacement skills. Manipulation skills are one of the most important body movements, because people perform thousands of movements related to manipulation skills every day. To justify the poorer performance of manipulation skills compared to movement skills, it can be pointed out that manipulation requires coordination between all parts of the body and the interaction of organs, such as eye-hand coordination or eye-foot coordination. These skills are closely related to mental activity, and due to anterior cortical injuries in children with ADHD, manipulation skills are less advanced compared to movement skills. Also, in fine motor skills, fine muscle control is used more, and because this child was weak in fine muscle control, as a result, he could not show good performance of moving skills.

In the study of cognitive skills data, the results showed that physical exercise improved the child's performance in the post-test phase. This result is consistent with the results of Amouzadeh et al. (2015), Shoushtari (2011) and Verret et al. (2012) (20, 23, 28). These results are consistent with perceptual-action theory, which states that the concepts of motion and performance are not separate and that perception cannot be studied independently of motion. It also seems that the subject consumes a significant amount of energy after participating in gymnastics training sessions, which creates a favorable feeling in the child, which leads to increased accuracy and attention in the implementation of cognitive skills (20).

V. Conclusion

In general, the results of the present study show that perceptual-motor training and experience is a positive factor in the development of motor skills, including displacement and manipulation skills. Based on the results of the exercise, it can be said that the more skilled a person is in performing coordinated movements, the greater the ability to control the nerve and organize between the elements and systems involved in that movement. Therefore, for a more coordinated execution of a movement, the degrees of freedom are reduced and in fact less systems, joints and muscles are involved to perform the movement, which causes less energy consumption and energy optimization to perform the same movement (29). These findings are contrary to the initial developmental view, including the view of maturity in motor development.

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