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THE EFFECT OF METHYLPHENIDATE TREATMENT ON EXERCISE PERFORMANCE IN CHILDREN WITH ATTENTION-DEFICIT HYPERACTIVITY DISORDER

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ABSTRACT

The prevalence of attention-deficit hyperactivity disorder (ADHD) in the school-age population is 8–10%, with boys having higher prevalence than girls. Children with ADHD have reduced physical fitness characteristics and exercise capacity compared to healthy children. There are conflicting results regarding the effect of treatment on exercise performance in children with ADHD. We determined fitness characteristic in children with ADHD receiving methylphenidate treatment (17.5±0.6 years; n=16) compared to age-adjusted ADHD children not receiving treatment (17.2±0.7 years; n=16). There were no significant differences in anthropometric measures between the treated and non-treated participants. There were no significant differences in the 60 seconds sit ups number, number of pull-ups, 4X10m shuttle run times and 2000m running times between the treated and non-treated participants. Standing long-jump results were significantly better among the non-treated ADHD participants ($p<0.02$). The results suggest that methylphenidate treatment might be disadvantageous for maximal speed and explosive-type activities in ADHD patient. Further studies are needed to clarify if other sports activities which require

attention, accuracy, concentration and organization may benefit from such treatment.

Key words: ADHD, methylphenidate, exercise, children

INTRODUCTION

Attention-deficit hyperactivity disorder (ADHD) is a neurobehavioral disorder defined by symptoms of inattention, hyperactivity, and impulsivity. The estimated prevalence rate in the school-age population is 8–10%, with boys having two to three times higher prevalence than girls. Symptoms of ADHD persist into adolescence in 60–80% of the patients, and many continue to have symptoms in adulthood. A leading pathophysiologic hypothesis of ADHD is based on the notion of a catecholamine (CA) dysfunction [6, 7]. This hypothesis suggests that the catecholamine response to environmental stimuli is attenuated in ADHD and is derived primarily from observations that drugs such as methylphenidate (considered to be CA agonists) are effective in treating ADHD symptoms [7].

Previous studies reported that children without ADHD perform significantly better and achieved higher scores in specific skills such as dribbling, kicking, throwing and catching, compared to children with ADHD [3]. Similar results were found when children were asked to performed physical tasks that involve speed and accuracy [2]. The ability of children with ADHD to perform physical tasks that involve high level of coordination was also examined. Hickey et al. [4] have found that children with ADHD had more difficulties in controlling sports oriented objects such as balls compared to non ADHD children. Similarly, ADHD children were found to have more difficulties in hitting the ball in a baseball game than non ADHD children [5]. In another study, ten years observation revealed that 6–8 years old children with ADHD improved significantly less than children without ADHD when coached for basic physical skills such as hops, jumps, side walk and backwards walk [2]. The investigators concluded that physical limitations in children with ADHA sustain throughout life even when practiced continually during maturation. It was speculated that a major reason for the performance inferiority of ADHD children is that they do not put as much effort in training as other children do, and this leads to low self-esteem and lower training impact [5].

The effect of medical treatment on physical performance of children with ADHD is not clear. While it was shown that the use of methylphenidate improves focus, attention, preplanning and ability to complete missions [1, 4, 5], and as a consequence performance in sport-types that require these characteristics, it does not necessarily improves other specific physical skills. Harvey et al. [3] failed to find any improvement in basic motor skills of ADHD children after methylphenidate therapy. Moreover, the use of methylphenidate was associated with a reduction in sport performances that involve speed and power. In addition, the use of methylphenidate was found to increase resting and sub-maximal heart rate, and as a result to impair aerobic performance [2].

The aim of the present study was to examine the effect of treatment with methylphenidate on the physical performance of children with ADHD. We hypothesized that the use of methylphenidate will improve activities that required attention and balance, but impair aerobic and anaerobic capabilities.

METHODS

Participants

Participants included 32 high school boys (16–18 years old) that were diagnosed as ADHD according to accepted criteria. Sixteen ADHD participants were treated with Methylphenidate, while the other 16 ADHD participants were not treated with any medications.

Testing procedure

Each group performed a set of physical test in the following order: 4 X 10 m shuttle run, standing long jump, sit ups, pull ups and 2000 m run.

4 X 10m Shuttle Run – Agility Test

The agility test involved a 4 X 10m shuttle run. The participant began at the base line and ran at maximal speed to a marked line that was located 10m ahead of him. He then turned and ran back to the baseline, turned again and performed the same back and forth run. This procedure was performed twice and the fastest time of the two trials was recorded. The participant rested for 5 min between the two runs.

Standing long Jump – Legs Power Test
Horizontal jump length was measured by a maximum jump using the counter-movement technique. Participants began in an erect standing position, moved into a semi-squat position and leaned forward, before jumping horizontally as far as possible. Three trials were completed with the participant using a vigorous double-arm swing as he jumped off the ground. The longest jump achieved was recorded. All jumps were performed in a long jump pit filled with soft sand. Jumping length was measured manually using a standard measuring tape.

60sec Sit ups – Abdominal Power Test
The participant laid down on the ground with is legs bended and foot attached to the ground by a fellow assister. The participant had to elevate his upper body to 30° off the ground before getting back to starting position. The participant had to keep his hands behind is head at all times. The participant was asked to perform as many elevations as possible during a period of 60sec.

Pull ups – Arms Strength Test
Pull ups were performed on a hanging bar located over the participant head. The participant had to hold the bar with both hands and straight arms. He then had to pull his body up and reach the bar with his chin. No movement of the body to the sides or back and forth was allowed while elevating the body up and down. The participant had to repeat and elevate his body as many times as possible with no time limit.

2000m Run – Endurance Test
The endurance test consisted of a 2000m run. The run was performed on a 400m lap track. The participants ran the 2000m as a group while each used his own tactics to produce the best possible result. Split times were reported to the participants upon completion of each lap. Final times for the run were rounded to full second units.

The participants were familiar with all the testing procedures as they routinely performed them in previous years. Both groups, untreated and treated with methylphenidate, performed the tests during the early morning hours when the effect of the medication is most powerful. The order of testing was similar in both groups. Before starting the first test the participants performed a standard warm-up procedure that included 8 min of jogging followed by 10 minutes stretching exercise and two 20m sprint runs. A 20–25 minutes time

period separated between tests while participants were rested and prepared for the next performance. All tests were performed in the same general location and in standard and comfortable environmental conditions.

RESULTS

Anthropometric and fitness characteristics of the study participants are summarized in Table 1. There were no significant differences in anthropometric measures between the treated and non-treated ADHD participants. There were no significant differences in the 60sec sit ups number, number of pull ups, 4X10m shuttle run times and the 2000m running times between the treated and non-treated ADHD participants. Standing long-jump results were significantly better among the non-treated ADHD participants ($p<0.02$).

Table 1. Anthropometric and fitness characteristics of the study participants.

	Non-treated ADHD (n=16)	**Treated ADHD (n=16)**	**P value**
Age (years)	17.5±0.6	17.2±0.7	0.15
Height (cm)	177.9±4.2	176.8±2.2	0.47
Weight (kg)	69.5±4.1	70.9±5.9	0.40
Abdomen (#/min)	71.6±10.2	70.6±19.8	0.86
Pull-ups (#)	9.6±5.6	10.1±7.2	0.85
Long-jump (m)	2.25±0.22	2.06±0.24	0.02
4X10m (sec)	9.98±0.56	10.35±0.82	0.15
2000m (min)	10.67±1.60	10.79±2.18	0.86

DISCUSSION

There is a general agreement in the scientific literature that children with ADHD have reduced physical fitness characteristics and exercise capacity compared to healthy children. Decreased performance of ADHD children was found mainly in movement skills (e.g. running, jumping, skipping, hopping), sports-object oriented activities (e.g. dribbling, kicking, throwing, catching) and activities that mandate precision and accuracy [2, 3, 4, 5]. It was suggested that one of the

mechanisms responsible for the reduced performance is the inability of children with ADHD to sustain the training process.

The concept that treatment of children with ADHD will improve exercise performance is not obvious. On the one hand, improvement in attention and concentration [1, 4, 5] may improve activities that may benefit from improved precision and accuracy (such as fencing, target or arrow shooting and even basketball throwing), or sports activities that need pre-planning strategy or tactics (like playmaker in a basketball game or even long distance runner that needs to pace running speed), and in situations that the athlete needs to ignore its surrounding (such as noisy and hostile crowd). On the other hand, in sports types characterized by explosive activities (jumping sports), aggressiveness (judo, wrestling, taekwondo) or in situations that hypermobility may give competitive advantage (aggressive defense in ball sports), treatment may reduce exercise performance [2, 3]. Thus, studies regarding the effectiveness of treatment for exercise performance in ADHD children have yielded conflicting results. All together, it is suggested that activities which need attention, concentration, precision and organization may benefit from methylphenidate treatment. In contrast, in aerobic activities, or maximal speed and explosive activities, treatment may be disadvantageous. In most cases, the therapeutic effect on exercise performance results from the drug's effect *per se*. However, the detrimental effect of methylphenidate on aerobic activities [2] results from one of its more common side effects, tachycardia, which occurs during resting conditions and during sub-maximal exercise, and therefore, lowers sub-maximal and maximal oxygen consumption.

In the present study, anthropometric measures were similar between the treated and non-treated ADHD children, thus any difference in performance cannot be attributed to the participant's physique or body size difference. In addition, all exercise tests were performed in the morning hours to guarantee the effectiveness of methylphenidate treatment. Consistent with our hypothesis, standing long-jump performance of the non-treated ADHD children was significantly better than treated children. In contrast, there were no statistically significant differences in the abdominal power test, arm strength test, 4X10m agility test and the 2000m endurance test between the treated and non-treated children. It is possible that these tests are not sensitive enough, and that more complex activities are needed, to find difference between treated and non-treated ADHD

children. It is also possible that a larger sample size is needed to find exercise performance statistically significant differences between treated and non-treated children.

In conclusion, it is very important to recognize the exercise performance differences between treated and non-treated ADHD children. Understanding of these differences can assist physical education (PE) teachers during PE classes to find the best way to encourage participation, improve performance and optimize socialization of ADHD children. Acknowledgment of physical fitness characteristic of ADHD children, and the treatment-induced performance changes will help PE teachers to find the best training modalities to strengthen weaknesses and improve performance. This is particularly relevant to athletes with ADHD in order to optimize their training programs and even to direct them to participate in sports types that they may better develop and express themselves. Moreover, since the majority of practices and competitions take place in the afternoon and evening hours when the effect of methylphenidate treatment ceases, it is important that treatment will cover the hours of practice and competitions in ADHD athletes in sports-types that mandate attention, concentration accuracy and organization.

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