Effect of Regular Aerobic Exercises on Behavioral, Cognitive and Psychological Response in Patients with Attention Deficit-Hyperactivity Disorder

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Abstract: ackground and purpose: Attention Deficit-Hyperactivity Disorder (ADHD) is a common behavioral disorder started in childhood and is characterized by one or a combination of three behaviors, named hyperactivity, inattentiveness and impulsiveness. The aim of this study was to find out the value of aerobic exercises on symptoms of ADHD. Patients,Materials and Methods: This study included 84 students diagnosed as having ADHD. Their age ranged from eleven to sixteen years. The students were randomly divided into two equal groups. The exercise group received ten weeks aerobic exercises program included upper limb, lower limb, trunk and neck exercises as well as running three sessions per week(In the first four weeks the session lasted for about 40 minutes and in the last six weeks the session extended to be 50 minutes). Behavior Rating scale was used to assess the students behavior before starting and after the end of ten weeks of the exercise program. Results: Results of the exercise group revealed a significant improvement in three of the five items involved in the scale(attention, motor skills and academic and classroom behavior) with $p < 0.05$ while there was no improvement in the the control group ($p > 0.05$). Conclusion: It could be concluded that regular aerobic exercises program has a positive effect in improving symptoms of ADHD.

[Gehan M. Ahmed and Samiha Mohamed. **Effect of Regular Aerobic Exercises on Behavioral, Cognitive and Psychological Response in Patients with Attention Deficit-Hyperactivity Disorder,** Life Science Journal. 2011;8(2):392-397] (ISSN:1097-8135). http://www.lifesciencesite.com.

Key words: Aerobic exercise-Cognition-Behavior-Attention Deficit Hyperactivity Disorder.

1. Introduction

Attention deficiency hyperactivity disorder (ADHD) is one of the most common neurobehavioral disorders. Patients with ADHD have trouble paying attention, controlling impulsive behaviors (may act without thinking about what the result will be), and in some cases are overly active[1].

ADHD is characterized by a persistent pattern of impulsiveness and inattention, with or without a component of hyperactivity[2]. This disease is diagnosed twice as frequently in boys as in girls. As they mature, adolescent and adult with ADHD are likely to develop coping mechanisms to compensate for their impairment[3]. Baumgardner et al.[4], studied patients with ADHD and discovered morphological asymmetry in the caudate nucleus of the corpus striatum. The caudate nucleus is mainly dopaminergic and the asymmetry weakens the reception of the dopamine signal by this structure. Thus, ADHD is believed to be caused by a slight abnormality in the brain caused either genetically or by prenatal complications[5].

Differences in distributed cortical and sub-cortical networks that support basic cognitive functions (such as attention, motor control and self-regulation) have been proposed as a neural basis for ADHD[6]. Reduced volumes within-hemisphere (corticocortical) and callosal white matter have been noted in ADHD. These suggested the possibility that the symptoms of ADHD may be related to impaired interactions within brain networks, rather than impaired function of specialized cortical regions[7]

ADHD is characterized by reductions in regions of the corpus callosum, frontal lobes, basal ganglia, and cerebellum. These networks involve input-output processing of attention, including alerting and executive functions. Deficits in attention, information processing, alerting, orienting and working memory may be mediated primarily in the prefrontal cortex[8]. Deficient connectivity between hemispheres induced state of over-connectivity within and between frontal hemispheres. Patients always seem to be in motion and may move around touching or playing with whatever is around, or talk continually. Some patients wiggle their feet or tap their fingers[9].

Thus, self-perceptions of patients with ADHD are low with regards to their feelings on behavior, ability to get along with others and to succeed in school. Self-perceptions are poor and over time they become increasingly more doubtful about their ability to cope with academic and social issues during adolescence[10,11]. A growing number of practitioners and researchers suggest that a regular program of physical exercise may lead to lower stimulant doses for those who still need medication[12].

Previous studies[13,14] suggested that the exercise regimens can help brains remain vital and healthy well. Exercise almost immediately elevates dopamine and nor-epinephrine and keeps them up for a period of time. It also helps to still the impulsivity and still the cravings for immediate gratification as it works to wake up the executive function of the frontal cortex, which in turn allows for delay, better choices, a bit more time to evaluate consequences[11]. The purpose of this study was to investigate the effect of regular aerobic exercises on behavioral, cognitive and psychological problems related to ADHD.

2. Patients and Methods:

Eighty four students from both gender (54 boys 30 girls) with ADHD participated in this study. Their age ranged from eleven to sixteen years. They were recruited from Special Needs Schools in Riyadh (Riyadh El Salehen, El Maaref and El Rawda Schools). All patients were functionally independent, could understand well, follow orders and cooperative. The students were excluded if they had;(1) Medical or systemic problems such as hypertension, hypotension, diabetes mellitus,(2)Musculoskeletal deformities (scoliosis, kyphosis , pes cavas),(3) Neurological problems (sensory or motor deficit),(4)Orthopedic problems (including past history of trauma before application of the study at least two months),(5) Rheumatic fever,(6)Obesity.

Instrumentation:

The Behavior Rating Scale is a modified version of Conner's Rating Scale[15]. The scale has been validated for screening and assessing behavioral, cognitive and psychological problems related to ADHD[16]. The scale provides a reliable, accurate and relatively brief measure of perception of disruptive behavior[17]. It consists of 25-behavior related questions, subdivided into categories for attention, motor skills, task orientation, emotional and oppositional behavior and academic and classroom behavior. The higher the score, the better behaved the student.

Procedures:

Prior to commencement of the exercise program, the students, teachers and the parents attended an information session. The aim and the procedures of the study were explained in details to the school manager, parents and teachers. Detailed explanation about exercise program was taught to the students before starting the study. Ethical approval was received from the schools administration to participate the students in the study. The students were assigned randomly into two equal groups (control and exercise). The exercise group received exercise program for ten weeks as three sessions per week.

The control group did not receive any designed exercise program.

Evaluation protocol:

The students were evaluated using the Behavior Rating Scale Pre and post exercise program. The Scale was filled from the teachers by the interviewers. During the study, the teachers were asked to observe the students for any changes, either positive or negative, in the school behavior, psychological statement and class concentration .The teachers helped in taking the suggestions of the students, and give any ideas about the application of the session.

Exercise protocol:

The moderate-intensity exercise program[18] was applied three sessions per week. Exercise program included upper limb, lower limb, trunk and neck aerobic exercises in addition to free running. Ten repetition for each exercise increase with time, rest period two minutes between every 15 minutes.

• **In the first four weeks** the session lasted for about 40 minutes, ten minutes preparation and warm up, 20 minutes aerobic exercise and five minutes with walking between exercises, at the end five minutes walking around the school with each other for cooling down.

• **The following six weeks,** the session lasted for about 50 minutes. Ten minutes warm up, 30 minutes aerobic exercises, five minutes walking around the school building, and five minutes slow walking and stretching for cooling down. The cool down phase include relaxation exercises. The aim of the relaxation exercises was to reduce the student's heart rates back to or close to resting levels.

• **Home program,** Parents were instructed to start home program for the study group from the 6thweek and continuous to the 10th week. The home program included walking half an hour out-door in the week-end.

Statistical analysis:

Intra-rater reliability between interviewers was conducted for the first 20 interviews. To determine any significant changes in behavior, all variables were subjected to analysis of variance (ANOVA) with repeated measures. Tukey's post –hoc tests were used to determine significant differences. The level of significance was set at $p<0.05$.

3. Results:

The students's physical characteristics were: age; study group (13.9±1.6), control group (13.8±1.7

years), weight; study group (42.10±4.2 kg.), control group (41.11±4.1 kg.) and height; study group (149.46±3.8 cm.),control group (152.33±4.1 cm.). There were no significant differences between both groups related to general characteristics.

Statistical analysis showed that there was an improvement in the Behavior Rating Scale scores for students in the exercise group while there was no significant changes (P > 0.05) in behavior, cognitive or psychological problems in the control group who did not receive any exercise program(Table 1&2).

Table (1): Comparison between the mean values of attention, motor skills , task orientation, emotional and oppositional behavior, academic and classroom behavior before and after exercise program in the study group.

Variable	Before Mean± SD	After Mean± SD	P-value
Attention	4.89 ±1.25	8.46±3.61	0.001*
Motor skills	4.11 ± 5.94	7.97 ± 3.96	0.01*
Task orientation	0.41 ± 0.87	0.35 ± 0.61	0.14
Emotional &Oppositional behavior	3.94 ± 2.61	2.71 ± 3.14	0.87
Academic& classroom behavior	22.24 ± 4.26	30.24 ± 7.27	0.008*

Significance* <0.05. SD: Standard deviation.

Table (1): Comparison between the mean values of attention, motor skills , task orientation, emotional and oppositional behavior, academic and classroom behavior before and after exercise program in the control group.

variable	Before Mean± SD	After Mean± SD	P-value
Attention	4.91 ± 7.68	5.62 ± 7.15	0.56
Motor skills	5.36 ± 5.95	4.95 ± 6.07	0.08
Task orientation	0.32 ± 2.86	0.82 ± 2.82	0.87
Emotional &Oppositional behavior	3.36 ± 2.54	3.45 ± 2.68	0.23
Academic& classroom behavior	22.27 ± 6.91	23.00 ± 5.83	0.21

Significance* <0.05. SD: Standard deviation.

There were no significant differences between both groups at the beginning of the study (P>0.05). After cessation of the exercise program for the study group, the following behavior categories were significantly improved in the study group compared to the control group: attention (P=0.005), motor skills (P=0.04) and academic and classroom behavior (P=0.001). Task orientation and emotional and oppositional behavior were not significantly altered after the ten weeks of exercise program with P>0.05(Table 3 & Fig.1).

Table (3) .Comparisons between mean values of Behavior Rating Scale after exercise at the end of the study of both groups (study and control).

variable	Study group Mean± SD	Control group Mean± SD	P-value
Attention	8.46±3.61	5.62 ± 7.15	0.005*
Motor skills	7.97 ± 3.96	4.95 ± 6.07	0.04*
Task orientation	0.35 ± 0.61	0.82 ± 2.82	0.78
Emotional &Oppositional behavior	2.71 ± 3.14	3.45 ± 2.68	0.421
Academic& classroom behavior	30.24 ± 7.27	23.00 ± 5.83	0.001*

Significance* <0.05. SD: Standard deviation.

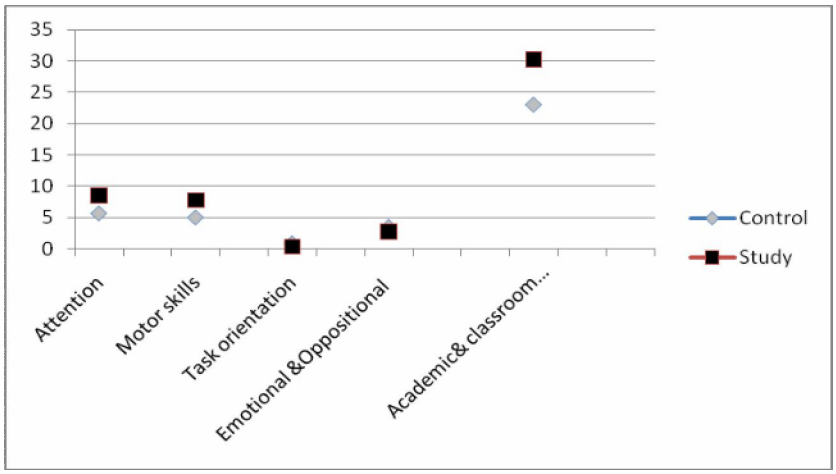

Fig.1. Mean values of Behavior Rating Scale after exercise program in the study and control groups.

4. Discussion:

Researchers have noted the positive role of exercises in the treatment of anxeity[19,20], depression, stress[21], and enhancing general mood state[22]. Based on these previous researches, it was hypothesized that an exercise program would significantly improved the behavior in patients with ADHD compared with that of non- exercised controls. The present study examined the alterations in the behavior, cognition and psychological problems of students with ADHD after ten weeks moderate intensity exercise program. There were significant improvements of the study group in three items of five from Behavior Rating Scale (attention, motor skills and academic and classroom behavior).

The results of the present study agree with the findings of Maddigan et al.[23], who concluded that exercise therapy would be effective in reducing symptoms or medication dose in attention deficit hyperactivity disorder in school age children who were already stabilized on medication. The improvement in inattentiveness was also supported by Went[24]who stated that there was positive shift observed in concentration among subjects with ADHD after they participated in therapeutic movement therapy. The results showed positive improvements on working speed, social and behavioral problems.

Possible explanation for improved behavior may therefore be that the exercise sessions encouraged co-operation in group situations and fostered tolerance and acceptance[5]. Hoza et al.[26] reported that friendship forming in ADHD students is associated with improved behavior. The social interactions in the exercise group during the exercise sessions, as well as during school may therefore resulted in improved behavior. Most student tend to be more active and attentive at the end of the program. The student in the exercise group stated that they enjoyed this activity and the parents found this to be of benefit for them.

Taylor and Kuo[11] reported that exercise helps to heighten the response to stressors, that is, the students became less stressed to the same stressors when in a fit condition. The researcher also mentioned that, mood is made better by raising the levels of neurotransmitters that works as antidepressants (dopamine, norepinephrine, and serotonin). All of these neurotransmitters get jacked up by exercise. Exercise reenergizes depressed brains to do its job of adapting to environment.

The results of the present study agree also with the results of Tantillo et al[27]., who suggested that exercise is beneficial to subjects with ADHD. However, the results disagree with a few studies which have been published in this area and have either been case reports of only one or few subjects[28-30], or failed to test implement valid behavioral measures[31].

Coe et al., [32] suggested that exercises could play a significant role in the classroom by improving attention and learning problems. Miller et al.,[33]found that schools that offered a more intense physical activity program tended to have pupils who demonstrated higher concentration levels. In addition, these pupils demonstrated improved reading, writing and mathematics scores. This overall positive effect on academic performance was also found when the physical activity time reduced time for academic teaching.

Dwyer et al., [34] studied Physical fitness and academic achievement in sixth and seventh grade students and their study confirmed that physical fitness is generally associated with improvement of academic performance in elementary school. Aerobic fitness and behavior test scores were associated with achievement of reading and mathematics. The authors regarded these improvements in academic

achievements to the effect of exercises on behavior including attention and concentration. The study concluded also that student's physical competency improves self-esteem perceptions and emotions.

5. Conclusion:

It was found that ten weeks exercise program as three times per week improved behavior of students with ADHD. So, exercises may be considered as an additional treatment required for improving the behavior in patients with ADHD.

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4/4/2011