

Effect of a Structured Exercise Program on Attention Span, Behaviour and Motor Skills in Children with Attention Deficit Hyperactivity Disorder

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Abstract: ***Background:** Hyperactivity, inattentiveness, and impulsivity are the three behaviours that define Attention Deficit - Hyperactivity Disorder (ADHD), a common behavioural disorder that typically first manifests in childhood. It is thought that prenatal problems or a mild brain abnormality brought on by heredity are the causes of ADHD. Reductions in the regions of basal ganglia, cerebellum, frontal lobes, and corpus callosum are characteristics of ADHD. Input - output attention processing, including alerting and executive functions, is involved in these networks. In the central nervous system's synaptic clefts, physical activity is thought to increase dopamine and norepinephrine availability. **Objective:** To find out the effect of a structured exercise program on attention span, behaviour and motor skills in children with attention deficit hyperactivity disorder. **Study selection:** This narrative review is conducted on databases from Pub med, Google scholar, ResearchGate and Cochrane library in Nov 2023. This review included 7 studies on the effect of physical therapy on various parameters in ADHD. **Conclusion:** The main symptoms of attention deficit hyperactivity disorder in children can be improved by physical activity, but there aren't many studies comparing the benefits of physical activity for boys and girls with ADHD or for adolescents and non - adolescents with the disorder. Therefore, it is necessary to include all age groups and take into account both male and female populations in order to develop a definitive protocol for children with ADHD.*

Keywords: ADHD, physical activity, attention span, gender differences, age groups

1. Introduction

Attention - deficit/ hyperactivity disorder (ADHD) is a neurodevelopmental disorder characterized by inappropriate hyperactivity, impulsivity, and inattention with onset in early childhood and a high rate of persistence into adulthood.¹ It being one of the most prevalent childhood behavioural disorders is characterized by one or a combination of the following three symptoms: inattention, impulsivity, and hyperactivity. There is also some evidence that these children have deficiencies in their gross and fine motor skills as well as their physical fitness.^{2,3}

The prevalence ranges from 5.3% to 20% globally, while in India, it ranges from 5.2% to 29.5%.³ Boys are diagnosed with this illness twice as often as girls.⁴

In order to be diagnosed with ADHD, a person must exhibit signs of inattention, hyperactivity, and/or impulsivity for at least six months in at least two areas of their life and before the age of seven.⁴

ADHD is characterized by a persistent pattern of impulsivity inattention and hyperactivity.⁶ Inattention, hyperactivity, trouble planning tasks, such as schoolwork and job duties, and impulsive behaviour are the main symptoms of ADHD. The majority of people with ADHD also have concomitant oppositional, conduct, anxiety or mood problems.⁵

The dorsolateral prefrontal cortex (DLPFC), which has strong links to other brain areas, is thought to control human motor, cognitive, and emotional responses. Moreover, the

DLPFC receives projections from numerous arousal neurotransmitter pathways in the brain that involve norepinephrine, dopamine, acetylcholine, and serotonin.⁷ There is evidence that the caudate nucleus of the corpus striatum has anatomical asymmetries in children with ADHD. The caudate nucleus is mostly dopaminergic, and the asymmetry makes it more difficult for this region to receive dopamine signals.⁶ Another suggested theory is linked to disturbed catecholamine neurotransmission, which states that people with ADHD have lower amounts of the neuro transmitters dopamine and norepinephrine in the brain regions connected to executive functions and attention, which lowers cognitive function.⁸

Children with ADHD are known to struggle with motor coordination and finding it challenging to complete several motor activities at once or in a sequential order. It is commonly known that children with ADHD have poor fine motor coordination, and a few studies have also revealed motor skill issues with the control of large motions including synkinesis, running, climbing, hopping on one leg, and tasks requiring the stabilisation of the trunk.¹⁰

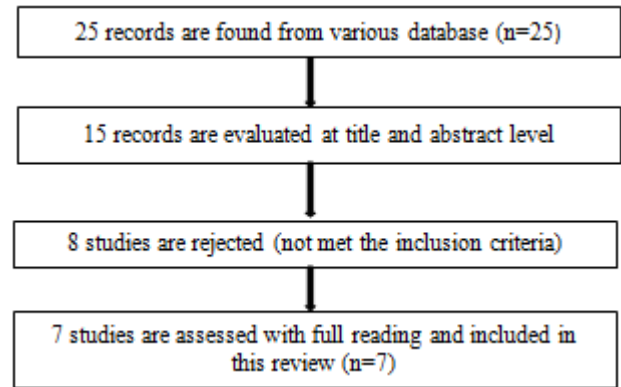
Physical activity increases the availability of dopamine and norepinephrine in synaptic clefts of the central nervous system. Further, there is evidence that PA results in changes in cerebral structure that are expected to be important for cognitive performance. These changes include the maintenance of cerebral vasculature and an increase in angiogenesis and neurogenesis, which all serve to enhance neuroplasticity and positively influence cognitive abilities.¹¹

Exercise has been considered as a potential protective factor for ADHD since some research suggests that it enhances neurocognitive performance in children with ADHD. Exercise in particular may improve attention and cognitive function by releasing dopamine (DA) in the brain. As a result, it may be utilized to control hyperactivity and inattentive symptoms in ADHD patients.¹

2. Material and Methods

Studies are search from the following search engine Pubmed, Google scholar, ResearchGate and Cochrane library to review the literature. Study include to investigate the effect of physical activity on behaviour, attention and motor skills in patients with attention deficit hyperactivity disorder.

Key words used are attention span, motor skills, behaviour, anxiety, depression, attention deficit hyperactivity disorder.



Several studies have shown that following a structured exercise program for a certain time period in children with attention deficit hyperactivity disorder have led to significant improvements in attention span, behaviour and motor skills.

Authors, Journal, Year	Objectives	Design	Characteristics of participants, sample size	Methods	Outcome measures	Results	Limitation
McKune et al.2003 ²	Behavioural response to exercise in children with attention deficit/hyperactivity disorder.	Experimental design	13 ADHD, 10 boys and 3 girls	Plyometrics (one leg hops, tuck jumps), aerobic exercises (running, obstacle running, skipping, relay races) for 5 weeks (5 days a week, 60 mins of exercise)	Modified conner's parent rating scale was used to rate children's behaviour 1 week before, after 3 weeks and immediately after 5 week period.	Motor skill components, emotional component and behaviour improved as measured on the modified conner's parent rating scale	The small sample size particularly of the control group made it difficult to randomize. The influence of increased attention paid by the parents during the rating of behavior and activities was not controlled
Ahmed GM, Mohamed S 2011 ⁶	Effect of regular aerobic exercises on behavioral, cognitive and psychological response in patients with attention deficit - hyperactivity disorder	Experimental design	84 subjects, 42 ADHD and 42 control	The exercise group received 10 weeks of aerobic exercises program which 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 student's behavior before starting and after the end of ten weeks of the exercise program	Significant improvement in attention, motor skills and academic and classroom behavior was seen in the experimental group as compared to the control group.	The sample size and associated statistical power was not large enough to consider any sub - group analyses.
meBler et al.2016 ¹⁸	Multimodal Therapy Involving High - Intensity Interval Training Improves the	Single - center, two - arm randomized,	28 boys	24 Min session for HIIT versus 60 min session for low to moderate intensity exercise, thrice a week for 3 weeks	Attention assessed by DSM IV, cardiorespirator y fitness assessed by	Three weeks of multimodal therapy including HIIT improved physical fitness, motor skills, certain aspects of	The current investigation involved only boys. Did not know whether these

	Physical Fitness, Motor Skills, Social Behavior, and Quality of Life of Boys With ADHD: A Randomized Controlled Study	controlled design			VO2 max, motor skills assessed by movement assessment battery of children - II.	quality of life, competence, and attention in boys with ADHD	boys were preadolescent or adolescent.
Mayer JS et al. 2018 ¹	Bright light therapy vs physical exercise to prevent comorbid depression and obesity in adolescents and young adults with ADHD: A randomised control trail	A parallel group RCT with three arms	A total of 330 participants with ADHD, aged 14 - 30 years will be screened at four study centers.	Bright light therapy daily for 30 mins sun exposure (without UV component) in the morning or evening for 10 weeks. Exercise intervention included a) 5 min warm up b) 10 - 35 mins of muscle strength training c) 20 - 40 mins of aerobic training d) 5 min of flexibility/ stretching cool down.	Primary outcome is to measure change in the IDS - C30 score. Secondary outcome measure includes change in obesity, ADHD symptoms, health related QOL.	The interventions are portable, cost effective and almost entirely free of side effects. Therefore, they have the potential to act as adjuncts to treatment as usual or even as primary treatment in the future.	
Yu Zang, Med 2019 ⁵	Impact of physical exercise on children with attention deficit hyperactivity disorder	Evidence through meta analysis	14 studies of a total 574 participants with ADHD were included	276 participants were assigned to physical activity group whereas 298 participants were assigned to control group.	Hyperactive/impulsive symptoms; Anxiety and depression; Inattention symptoms; Oppositional symptoms; Thought problems; Social problems; Aggressive behaviors; Strength and agility; Internalized problems; Externalized problems; Perseverative errors; Non - perseverative errors; Stroop color - word response.	Results of this analysis showed that anxiety and depression were significantly improved with physical activity in these children with ADHD. Hyperactive/impulsive symptoms and inattention symptoms were also improved with physical exercise but the results were not statistically significant.	Only a total number of 574 participants were included. This minor number of participants might not lead to robust analysis. The type of physical activity varied in this study. One study involved adolescents with a mean age of 21 years whereas all the other studies involved children.
Jeyanthi S et al. 2021 ³	Effectiveness of structured exercises on motor skills, physical fitness and attention in children with ADHD as compared to typically developing children	A pilot study	10 school boys with ADHD of age 8 - 12 years and 10 typically developing children were recruited.	They underwent a 6 - week structured exercise program including aerobics, resistance exercises, motor skills and attention training.	Outcome measures include Vanderbilt teacher rating scale, motor skills, physical fitness and attention	Following a 6 week exercise program there were significant improvements in physical fitness, motor skills and attention in ADHD children as compared to TD children	Sample size was not large enough.
Dinu LM et al. 2023 ¹⁴	Effect of different exercise approaches on ADHD in Adults: a randomised	Randomised control trail	2 groups of adults with ADHD (N=82) and controls (N=77) were	Participants were randomly allocated to a 10 min of cycling (aerobic) or mind body (hatha	Outcomes included the core symptoms of ADHD: Inattention,	There were no effects of exercise on attention, cognitive or motor impulsivity, or movement in those	Participants could not be blinded to their condition, given the

	control trail		randomly allocated	yoga) exercise which included seated forward fold and chest stretches, child's pose and half down dog.	impulsivity and hyperactivity.	with ADHD. Exercise reduced attention and increased movement in controls. Exercise can improve temporal impulsivity in adult ADHD but did not improve other symptoms and worsened some aspects of performance in controls.	nature of the intervention. ADHD sample was female - dominated and means that results may not generalise to a more gender - balanced cohort
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3. Discussion

Several studies have shown that physical activity, both aerobic and resistance have shown significant improvements in inattention and hyperactivity on ADHD scales.

Jayenthi et al. reported in a study in 2021 that children with ADHD who participated in a structured, school - based fitness program for six weeks saw a reduction in their primary symptoms. The structured workouts recommended in this study were a safe, practical, and efficient way to help kids with ADHD become more fit. Together with this, there has been a noticeable development in both gross and fine motor skills. Research indicates that engaging in physical exercise elevates dopamine, norepinephrine, and serotonin levels. As a result, an increase in these chemicals may aid in improving focus and attention in children diagnosed with ADHD.³

Ahmed GM, Mohamed S (2011) studied the changes in the behavior, cognitive abilities, and psychological issues in ADHD children following a ten - week program of moderate - intensity exercise. Three of the five items on the Behavior Rating Scale (attention, motor skills, academic behavior, and classroom behavior) showed a substantial improvement in the research group.⁶

The current study's results are consistent with those of Maddigan et al., who found that in school - age patients with attention deficit hyperactivity disorder who were already on medication, exercise therapy would be beneficial in lowering symptoms or medication dosage.¹⁶

Yu Zang (2019) analyzed the data and provided evidence to demonstrate how exercise greatly reduced the symptoms of anxiety, depression, social issues, and violent behavior. The symptoms of inattention and hyperactivity/impulsivity were also lessened, though not significantly.⁵

Researchers found a strong correlation between physical sports and improved attention, cognitive, and social skills in children with ADHD. The study involved a 6 - week prospective trial with 12 sessions of education and sports therapy, and participants engaged in a 90 - minute athletic activity twice a week. These kids showed notable improvements in their social skills and cognitive abilities, which suggests that physical activity has a big influence on kids with ADHD.¹⁷

4. Conclusion

This study's main goal was to support the theories that exercise helps reduce children with ADHD's symptoms of impulsivity, hyperactivity, and inattention. In addition, it can help with behavioural issues, anxiety, depression, academic achievement, and the development of fine and gross motor skills. There is not enough data to investigate how ADHD affects boys and girls differently in terms of performance. It is important to plan future research to deepen our understanding of how acute and chronic physical activity affects ADHD behavioural and cognitive symptoms.

Exercises may therefore be regarded as an extra therapy that is necessary to help patients with ADHD manage their symptoms.

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