Long-Term Aerobic Exercise Regimens Can Help Improve Behavioral Symptoms in Children with Attention Deficit Hyperactivity Disorder

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Recommended Citation
Weaver, Christine and Vigliotti, Rachel, "Long-Term Aerobic Exercise Regimens Can Help Improve Behavioral Symptoms in Children with Attention Deficit Hyperactivity Disorder" (2017). School of Physician Assistant Studies. 615.
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Abstract

**Background:** Attention deficit hyperactive disorder (ADHD) is a complex and common neuropsychiatric disorder characterized by inattention, hyperactivity, and impulsivity. Though there is an abundance of literature investigating ADHD, the disorder remains difficult to understand, as it has genetic, metabolic, dietary, neurological, emotional, and parental components. Current preferred treatment of ADHD is a combined approach of behavioral therapy and stimulants but pharmacologic treatment has limitations in efficacy and can have a negative side effect profile. Physicians have had long believed anecdotally that exercise regimens may be helpful in managing symptoms of ADHD in children. This paper will discuss recent research that supports this belief.

**Methods:** Exhaustive search of available medical literature was conducted using Google Scholar and MEDLINE-PubMed. Keywords used were: “exercise and ADHD”, “physical activity and ADHD”, and “ADHD and cardio”.

**Results:** A total of 24 studies were reviewed for inclusion in this discussion. Three papers were selected. All of these papers showed encouraging evidence that supports the use of exercise to help manage ADHD symptoms. The studies were all moderate in strength and further research is necessary to help apply the use of exercise in the treatment of ADHD in clinical practice.

**Conclusion:** Exercise can be a useful tool to help manage symptoms of inattention and hyperactivity in children. Further research is necessary to help determine how much exercise is required, of what type (cardio vs strength, short vs long duration), and how it may be used as an adjunct to pharmacologic treatment.

**Keywords:** “exercise and ADHD”, “physical activity and ADHD”, and “ADHD and cardio”.

**Degree Type**
Capstone Project

**Degree Name**
Master of Science in Physician Assistant Studies

**Keywords**
Exercise, ADHD, cardio, physical activity, cognition

**Subject Categories**
Medicine and Health Sciences

This capstone project is available at CommonKnowledge: https://commons.pacificu.edu/pa/615
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A Clinical Graduate Project Submitted to the Faculty of the
School of Physician Assistant Studies
Pacific University
Hillsboro, OR

For the Masters of Science Degree, August 2017
Faculty Advisor: Saje Davis-Risen
Clinical Graduate Project Coordinator: Annjanette Sommers, PA-C, MS
Biography

[Redacted for privacy]
Abstract

Background: Attention deficit hyperactive disorder (ADHD) is a complex and common neuropsychiatric disorder characterized by inattention, hyperactivity, and impulsivity. Though there is an abundance of literature investigating ADHD, the disorder remains difficult to understand, as it has genetic, metabolic, dietary, neurological, emotional, and parental components. Current preferred treatment of ADHD is a combined approach of behavioral therapy and stimulants but pharmacologic treatment has limitations in efficacy and can have a negative side effect profile. Physicians have had long believed anecdotally that exercise regimens may be helpful in managing symptoms of ADHD in children. This paper will discuss recent research that supports this belief.

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Revised 07May2017
Acknowledgements

[Redacted for privacy]

Thanks mom and dad.
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Table 1: Quality Assessment of Reviewed Studies (remember this is mandatory)
Long-Term Aerobic Exercise Regimens Can Help Improve Behavioral Symptoms in Children with Attention Deficit Hyperactivity Disorder

BACKGROUND

Attention deficit hyperactive disorder (ADHD) is a complex and common neuropsychiatric disorder characterized by inattention, hyperactivity, and impulsivity. Though there is an abundance of literature investigating ADHD, the disorder remains difficult to understand, as it has genetic, metabolic, dietary, neurological, emotional, and parental components. It is one of the most common diagnoses in children, with current prevalence at 4.4% in school-aged children in the US. The current diagnostic criteria for ADHD is defined in the DSM-V as greater than or equal to 6 symptoms of hyperactivity or impulsivity, or greater than or equal to 6 symptoms of inattention in children less than 17 years of age. The symptoms must occur in more than one setting (eg, school, home, daycare), must last at least 6 months, must begin before age 12, and cause significant impairment in functioning.  

ADHD is a significant diagnosis because it affects many domains of a child’s life. Studies have shown that ADHD is related to increased
rates of academic failure, social isolation, and involvement in deviant peer groups. Additionally, children with ADHD struggle with performance in school, as they are often unable to complete assignments, frequently talk out of turn, and lose homework. ADHD also affects self-esteem, and impairs a child’s ability to cope with complex social issues. Greater than 50% of children with ADHD will experience disciplinary problems and as much as 33% of children with ADHD will have substance experimentation and abuse. Additionally, ADHD is often not the sole diagnosis, and children frequently suffer comorbidities such as learning (reading/writing) disabilities, anxiety, and depression.

ADHD is often thought of as a childhood disorder but in fact, 40-60% of child patients with ADHD will continue to have problems into adulthood. Adults with ADHD suffer higher rates of unemployment, accidents, and criminality. Research shows that adults with ADHD have anywhere from 1.5-7.9 times increased likelihood of suffering from a substance abuse disorder than those without ADHD. The implication of the aforementioned being: ADHD is not a problem isolated to childhood. ADHD is not a diagnosis to be “grown out of”. Though behavioral symptoms tend to be better controlled as the patient ages, the consequences and comorbidities continue throughout adulthood.
Research has shown that the pathogenesis of ADHD is complex and multivariable, including genetic, neuroanatomical, and metabolic components. Evidence shows that there is a concordance rate as high as 92% of ADHD in monozygotic twins, and up to 33% in dizygotic twins, suggesting a strong genetic link. Studies also show that children with ADHD show difference in expression of genes involved in dopamine and serotonin receptors and transporters. Neuroimaging studies of children with ADHD demonstrate structural and functional abnormalities in prefrontal structures and the basal ganglia regions of the brain, which are involved in motor inhibition and executive function. Finally, mice models of ADHD show a difference in catecholamine metabolism (norepinephrine and dopamine) in the prefrontal cortex. The normal responsibility of these neurotransmitters is to help regulate inattention, alertness, and executive function. Therefore, their disrupted regulation in ADHD helps contribute to the core symptom manifestations in patients.

Current preferred treatment of ADHD is a combined approach of behavioral therapy and stimulants. The first line pharmacologic treatment of ADHD is methylphenidate (known as Ritalin), with as many as 90% of children with ADHD using it. Methylphenidate is classified as a stimulant, and works by blocking reuptake of norepinephrine and dopamine into the presynaptic neurons of the
cerebral cortex. It has long been shown to decrease core symptoms of ADHD and has a long record of safety and efficacy. However, side effects of methylphenidate treatment can be numerous, and occasionally serious. These side effects include: insomnia, anorexia, weight loss, heart attack, chest pain, arrhythmia, alopecia, growth suppression, cough, and ironically can also cause mood disturbances, an increase in aggressive behavior, agitation, and confusion. As a consequence, patients often have poor medication compliance, and treatment has not been proven to have any long term benefits.

Whether it is a result of the negative side effects of pharmacological medication or parental stigma surrounding “over-medication” of their children, there has been a push to investigate alternative treatment modalities for ADHD. Exercise has long been shown to improve cognitive function in young adults, and exercise has been shown to decrease stress, anxiety, and depression. As such, clinicians have been anecdotally prescribing exercise regimens as an adjunct treatment modality in pediatric patients. There is a small body of literature that supports the use of aerobic exercise in treatment of ADHD, but the research that exists is extremely limited, and often the studies have small samples sizes, lack control groups, or remain unpublished. Thus, exercise as a prescription treatment of ADHD remains difficult, as there are no currently established or
defined exercise regimens, or even enough research to definitively support the use of exercise as treatment in the first place.

This literature review seeks to investigate the idea that exercise may be used as an effective treatment modality in children with ADHD. The review will specifically focus on the use of cardio-intensive, long-term exercise programs, and their effect on the behavioral symptoms of ADHD (rather than the cognitive symptoms), in school-aged children.

**METHODS**

A comprehensive search was conducted on Google Scholar and MEDLINE-PubMed using the key terms “exercise and ADHD”, “physical activity and ADHD”, and “ADHD and cardio”. Studies that focused on non-cardio intensive treatment regimens, adults, or acute exercise programs (rather than long-term) were excluded. Studies were included that focused on cardio-intensive, long term exercise and a pediatric population. Bibliographies were referenced for further sources. Articles were assessed using the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) method.
RESULTS

An initial search of Google Scholar and MEDLINE-PubMed using the aforementioned keywords revealed 24 articles. Three studies met the inclusion criteria to appropriately answer the clinical question. Unfortunately, each study has significant limitations, and their applicability to clinical practice is limited. However, the collection of literature does support the idea that long term, aerobic exercise regimens do help ameliorate behavioral symptoms in children with ADHD and may have a beneficial clinical utility for treatment.

Ahmed et al (2011)

The first study titled, “Effect of Regular Aerobic Exercises on Behavioral, Cognitive and Psychological Response in Patients with Attention Deficit Hyperactivity Disorder” was conducted by Ahmed et al. The study had a sample size of 84 children (n=84), and all subjects had an established diagnosis of ADHD and were aged 11-16. The study population was divided into two randomized groups and prescribed 10 weeks of aerobic exercise including upper limb, lower limb, trunk, and neck exercises, as well as running lessons 3 times per week. The first 4 weeks included 40-minute sessions of running and the last 6 weeks increased the duration to 50 minutes. Behavioral outcomes were assessed by a modified behavior rating scale (a variation on the commonly accepted Conner’s rating scale) before and
after the exercise regimen. The scale included 25 behavioral related questions divided into 5 categories. Results showed a significant improvement in 3 of the 5 behavioral symptoms listed in the survey, including inattention, motor skills, and classroom behavior in the exercise group, as compared to the control group. The exercise group showed an improvement of attention symptoms from 4.89 to 8.46 (p=.001), motor symptoms improved from 4.11 to 7.97 (p=.01) and academic performance symptoms improved from 22.4 to 30.24 (p=.008) as graded on the Behavioral Rating Scale Survey. No significant differences were noted before and after exercise intervention in any category for the control group (all p>.05).

Kang et al (2011)

The second study conducted by Kang et al in 2011, investigated the effect of sports on sociality, cognitive function, and attention symptoms in children with ADHD. The study was conducted over a 6-week time period and included 2 randomized groups, including 1 group (n=13) of ADHD children who participated in 90 minutes of athletic activity twice a week and 1 group (n= 18) which received 90 minutes of behavioral education twice a week. Children were assessed by DuPaul’s ADHD rating scores and parent and teacher rated attention and social scores before and after treatment. The exercise group engaged in aerobic activity which followed a format of 15 minutes of
aerobic exercise (shuttle runs, zig zag runs), 20 minutes of goal
directed exercise (cone retrieval), and 20 minutes of jump rope. The
control group received 90 minutes of educational intervention, which
was not specifically described in the study. The study showed the
exercise group had improved scores of attention, executive function,
and social cooperation as compared to the control group. Statistical
analysis was performed doing a Repeated measures Anova comparing
scores of inattention after intervention in both groups. Results showed
a significant difference in the two groups with \( P<0.01 \).

**McKune et al (2003)**

The third study looked at behavioral response to exercise in
children with attention deficit hyperactivity disorder and investigated a
5-week exercise program which assessed scores on the Conner’s
Parent Rating Scale to rate children’s behavior 1 week before, after 3
weeks of exercise, and immediately after the exercise regimen.
Thirteen children participated in the exercising group and 6 children
were in the control group. Of note, these groups were not randomized,
as stated in the paper “for logistical reasons” which were not further
clarified. Nonetheless, no significant difference existed between height,
weight, and average age in both the control and experimental group.
The exercise group met immediately after school 5 times per week for
5 weeks, and participated in varied exercise including relay runs, one
leg hops, and obstacle courses. Though the exercise varied, researchers aimed to have children stay at target HR for at least 20 minutes during the regimen. The control group abstained from exercise. Results showed no significant differences between Conner’s Rating scores pre and post regimen, but did show a significant difference in the scores between the exercise and control group after the completion of the study. Behavior categories as assessed by survey were significantly improved in the categories of total behavior (p=.001), attention (p=.008), emotional (p=.01), and motor skills (p=.004).^{17}

**DISCUSSION**

Results of all studies^{15-17} reviewed indicate that aerobic exercise may have utility in treating pediatric patients. Unfortunately, due to the sparsity of research on the topic, and the novelty of the concept, studies have yet to delineate specific recommendations for exercise protocols, and lack uniformity in how to implicate change in clinical practice. The studies reviewed all had substantial flaws which must be addressed in future research. First, the Ahmed et al study^{15} did not mention if the control group was engaged in a “control activity”. Some researchers have proposed that without a control activity (an activity or time in which the control group spends interacting with teachers or
parents in a non-exercise protocol), it is impossible to attribute behavioral improvement to exercise and not due to “extra time spent” interacting with children. This is referred to as the “extra attention affect”. Additionally, the Ahmed et al study\textsuperscript{15} did not have any specific measurement of exercise intensity (ex: no heart rate monitor was used). The Kanget al study\textsuperscript{16} was a Korean study and the Korean children were subject to substantial cultural differences in parenting and parental perception of child behavior, which is important considering the results were measured by parent completed rating scales. The study also lacked any specific measurement of exercise intensity, similar to the Ahmed et al study. The McKune et al study\textsuperscript{17} was lacking in robustness, as its sample sizes were quite small (exercise group n= 13 and control group n=6). Furthermore, there may have been a sex influence, as the entire exercise group was boys and the control group was entirely girls. This may have significant implications, as ADHD is 3 times as common in boys as girls.\textsuperscript{1} Further, all studies\textsuperscript{15-17} failed to demonstrate long-term maintenance of the behavioral benefits from the exercise regimens. Further research will be needed to investigate long-term implications of exercise as treatment. Additionally, future research must have larger sample sizes, as small sample sizes lead to poor reliability. Less robust studies, are prone to statistical errors and bias. Finally, the studies all
focused on children who were currently taking medication as their primary treatment. The prevalent attitude of clinicians is that pharmaceutical treatment is not only first-line but also the only viable option for ADHD symptom management. None of the studies in existence feature a sample group that was not medicated, in order to study the effects of exercise as an isolated treatment. Finally, each study heavily relied on subjective surveys to analyze behavioral changes in the patients. Subjective surveys certainly have validity in research, but also are prone to bias. Therefore, future research may benefit from an objective measurement of behavioral changes. Of additional concern is the fact that the reviewed studies only examined exercise as an adjunct to pharmacologic treatments. Future research may benefit from investigating medication-only groups, medication + exercise groups, only exercise groups, and control groups.

CONCLUSION

In conclusion, current research strongly suggests a benefit in the utilization of aerobic exercise to treat ADHD in the pediatric population. The implications to clinical practice may be numerous, including the elimination of, or at least reduction of pharmacologic agents in treating ADHD. Unfortunately, as evidenced by the increase
of childhood obesity and sedentary lifestyles, it is increasingly difficult to prescribe exercise as treatment, and practitioners are sure to have numerous complications with poor patient compliance. However, when weighing the risk of noncompliance against the risk of pharmaceutical side effects, aerobic exercise seems to be a better option than drugs alone. None-the-less, the research is promising, and further research may also help to address the issue of patient compliance, and may suggest mechanisms by which to involve exercise as part of a daily school-regulated regimen in children with ADHD.
References


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<sup>a</sup> No measure of exercise intensity  
<sup>b</sup> Subjective surveys used  
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