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Effectiveness of Physical Activity Intervention Programs on Reducing or Eliminating Behaviors
Associated with ADHD in Children

A Synthesis Project
Presented to the
Department of Kinesiology, Sports Studies, and Physical Education
The College at Brockport
State University of New York

In Partial Fulfillment
of the Requirements for the Degree
Master of Science in Education
(Physical Education)

by
Nicholas Riniolo
December 8, 2020

THE COLLEGE AT BROCKPORT
STATE UNIVERSITY OF NEW YORK
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Department of Kinesiology, Sport Studies, and Physical Education

Effectiveness of Physical Activity Intervention Programs on Reducing or Eliminating Behaviors
Associated with ADHD in Children

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12/8/2020

Instructor Approval

Date

Accepted by the Department of Kinesiology, Sport Studies, and Physical Education, The College at Brockport, State University of New York, in partial fulfillment of the requirements for the degree Master of Science in Education (Physical Education).

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12/8/2020

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Abstract

Attention deficit hyperactivity disorder (ADHD) is a prevalent disorder typically diagnosed during childhood that affects multiple domains of a child's life (e.g., academic, social). Core behaviors associated with ADHD include inattention, hyperactivity, and impulsivity which lead to the following diagnoses: inattentive type ADHD , hyperactive-impulsive type ADHD , or combination type ADHD. Commonly, ADHD is treated with psychostimulant medication and/or cognitive behavioral therapy. While these forms of treatment can be effective, they can also have negative side effects. The use of physical activity intervention (i.e., aerobic exercise, yoga, sports) may be a promising form of intervention for children who have ADHD in addition to more common forms of treatment. The purpose of this synthesis was to review the literature on the effectiveness of physical activity intervention programs on reducing or eliminating behaviors associated with ADHD in children.

Chapter 1- Introduction

In the United States, it is estimated that 3-7% of children have a diagnosis of attention deficit hyperactivity disorder (ADHD) (Gapin, Labban & Etnier, 2011; Lee, Dunn, & Holt, 2014). Consider the possibility of there being an even greater percentage of children who are exhibiting behaviors associated with ADHD but are not diagnosed. ADHD is a prevalent disorder typically diagnosed during childhood that affects the academic performance of children as well as their social life. In fact, it is the most common neurodevelopmental disorder in children. Core behaviors associated with ADHD include inattention, hyperactivity, and impulsivity. ADHD diagnoses include inattentive type, hyperactive-impulsive type, or combination type. In addition, ADHD may cause limitations in cognitive functioning as well as limitations with emotional and social competence (Cerrillo-Urbina et al., 2015).

ADHD may put psychological strain on children in their academic, home, and community environments (Kamp, Sperlich, & Holmberg, 2014). ADHD also proves to be highly comorbid with other mental, behavioral, and emotional disorders. Comorbidities are common and may lead to even more significant cognitive dysfunctions. Although ADHD is often perceived as a childhood disorder, the behaviors children exhibit as a result of ADHD may persist into adulthood. Although the behaviors may manifest differently in adulthood, ADHD can affect an individual's outcomes in college, their occupation, or their relationships (Bustamante et al., 2016). Taking all of this into consideration, it is important to focus on chronic rather than acute management of the behaviors associated with ADHD.

The most common form of treatment for ADHD is currently psychostimulant medication. It is important to consider that medications may have many unwanted side effects (Hoza et al., 2015). Negative side effects from psychostimulant medications may affect a child's emotional well-being as well as their mental and physical health. Every child will not react the same way when using different types of medication. It may take some trial and error to discover a medication and a dosage that works well for a specific child. In addition to pharmacological intervention, cognitive-behavioral therapy (CBT) is often used either in combination with medication or by itself. CBT is a form of psychotherapy that involves talking with a mental health specialist about strategies for managing negative thoughts and behaviors. However, CBT may have some negative side effects as well. These include non-response to treatment, becoming treatment dependent, or developing a poor tolerance to treatment (Cerrillo-Urbina et al., 2015). It crucial to understand that medication and cognitive behavioral therapy can be highly effective for some children. However, it is not always a long-term solution for some. Some children may react more adversely to these forms of treatment while others may benefit greatly. In addition to these forms of treatment, physical activity intervention may be a viable long-term treatment option.

Results from recent studies have shown that physical activity may be an effective form of intervention in reducing behaviors associated with ADHD. For example, different types of aerobic exercise and yoga have shown reduction in the cognitive (i.e., executive functioning), and somatic (i.e., general physical health) limitations associated with ADHD as well as associated behaviors (e.g., inattention, hyperactivity). In addition, Kamp, Sperlich, and Holmberg (2014) found that physical activity intervention lead to improved social skills and motor skills. Studies have also shown that physical activity intervention may target the same

neurotransmitters as stimulant medication, meaning physical activity may be effective in the reduction of behaviors caused by ADHD (Cerrillo-Urbina et al., 2015). In addition to improving health and fitness, physical activity intervention may also be viewed as a leisure activity or develop into a hobby for children. This form of intervention may decrease behaviors directly related to ADHD as well as behaviors related to comorbid disorders such as depression or anxiety (Lufi & Parish-Plass, 2011).

Statement of the Problem

ADHD is a prevalent disorder typically diagnosed during childhood, although behaviors resulting from ADHD can manifest into adulthood. For instance, inattention, hyperactivity and impulsiveness as well as limitations in cognitive, social, emotional, and behavioral functioning negatively impact quality of life (Kamp, Sperlich, & Holmberg, 2014). In children, ADHD may lead to academic struggles as well as problems with forming and maintaining peer relationships. In adulthood, these struggles may persist into college and into one's occupation. It is paramount that behaviors associated with ADHD be managed and treated early-on in a way that can be sustained throughout an individual's lifespan. ADHD treatment commonly consists of pharmacological strategies that include psychostimulant medication and/or cognitive-behavioral interventions. However, these methods are not always effective long-term for reducing behaviors associated with ADHD for all children (Hoza et al., 2015).

Although those treatment methods may be very beneficial for some children, it is important to expand horizons and search for other options that can be utilized in addition to medication or cognitive-behavioral therapy. Recent studies indicate that physical activity intervention can be effective in managing behaviors associated with ADHD in children. For instance, studies have found that physical activity intervention leads to a decreasing negative or

aggressive behaviors and strengthens emotional control and social skills (Lee, Dunn, & Holt, 2014). This is a promising area of study that requires further investigation to determine the clinical relevance for long-term effects of physical activity intervention on behaviors associated with ADHD. Exploring different treatment options for ADHD is essential for children who may not be responsive to more common forms of treatment. As children grow and develop, behaviors associated with ADHD may manifest differently and children will experience many changes in their academic and social settings that will be impacted by ADHD. Trying multiple treatment options and searching for long-term treatment is crucial for positively impacting a child's quality of life.

Purpose of the Synthesis

The purpose of this synthesis project is to review the literature on the effectiveness of physical activity intervention programs on reducing or eliminating behaviors associated with ADHD in children.

Operational Definitions

1. Attention deficit hyperactivity disorder (ADHD): Classified as a neurodevelopmental condition. Characteristics include combinations of hyperactivity, impulsivity, and inattention. These characteristics interfere with an individual's functioning across settings (Lee, Dunn, & Holt, 2014).
2. Cognitive behavioral therapy (CBT): A form of psychotherapy that involves talking with a mental health specialist about strategies for managing negative thoughts and behaviors.
3. Physical activity (PA): Any form of movement or exercise that expends energy (e.g., various forms of aerobic exercise, yoga, sports). Physical activity may be used as a leisure activity and

can be incorporated into an individual's daily routine to improve their overall physical and mental health.

Research Questions

This synthesis intends to answer the following questions:

1. What forms of physical activity intervention are effective in reducing or eliminating behaviors associated with ADHD?
2. Are certain forms of physical activity intervention more effective than others in reducing or eliminating behaviors associated with ADHD?
3. Is physical activity intervention sustainable as a long-term therapy treatment?

Delimitations

1. Research articles used in this synthesis were full-text, peer-reviewed articles published from 2010 to present.
2. Ages of participants in research articles ranged from 2 to 16 years old.
3. Participants were diagnosed with attention deficit hyperactivity disorder (ADHD) from a licensed psychologist using the DSM- IV or DSM-5 or they displayed behaviors associated with ADHD as described by a parent and/or teacher rating scale.

Chapter 2- Methods

The purpose of this chapter is to review the methods used to determine the effectiveness of physical activity intervention programs on reducing or eliminating behaviors associated with ADHD in children. The literature included in this synthesis was located through The College at Brockport's library website using the EBSCOhost database. While using the EBSCOhost database, the SPORTDiscus and Academic Search Complete databases were utilized.

Carefully considered keywords were used to narrow down the number of articles presented to a manageable amount. Keywords included: ADHD, attention deficit hyperactivity disorder, physical activity, exercise, intervention, treatment, therapy, children, adolescents, youth, child, effect, impact, influence, symptoms, and behaviors. Searches were conducted in a manner that included a combination of keywords using the Boolean operators (i.e., and, or, not). Boolean operators are used to focus a search when multiple keywords are being used, or they can be used to connect keywords within the search. The Boolean operator "AND" is used when searching for an article that must include multiple keywords that were used. The Boolean operator "OR" is used then searching for an article that may include one keyword or another. For example, the key words used in this synthesis were entered into databases as (ADHD OR Attention deficit hyperactivity disorder) AND (physical activity OR exercise) AND (intervention OR treatment OR therapy) AND (children OR adolescents OR youth OR child).

In addition to the use of keywords, articles were further narrowed down using the following criteria: (a) published between 2010 to present; (b) academic journal; (c) peer-reviewed; (d) full text available; (e) written in English. All articles selected for this synthesis met criteria a through e. Setting this criteria ensured that the literature reviewed for this synthesis contained information that was current and reliable. Within the SPORTDiscus and Academic

Search Complete databases, 30 articles that met criteria were reviewed and considered to be part of the critical mass of literature for the purpose of this synthesis.

A search through SPORTDiscus was completed in the following format using the Boolean/Phrase search mode: (ADHD OR Attention deficit hyperactivity disorder) AND (physical activity OR exercise) AND (intervention OR treatment OR therapy) AND (children OR adolescents OR youth OR child). This search yielded 66 results. When additional criteria was entered (i.e., criteria a through e), results were narrowed down to 22. To narrow down results even further, (effect OR impact OR influence) was added into the search yielding 18 results. Finally, searching NOT methylphenidate narrowed results down to 15 articles. The keyword methylphenidate was used to eliminate studies that focused on medication as the primary form of intervention. From there, the abstracts of promising articles were reviewed.

The same process and keywords were used through Academic Search Complete. Keywords were entered into Academic Search Complete in the following format using the Boolean/Phrase search mode: (ADHD OR Attention deficit hyperactivity disorder) AND (physical activity OR exercise) AND (intervention OR treatment OR therapy) AND (children OR adolescents OR youth OR child). 208 results were found. Incorporating criteria a through e, results were narrowed down to 52. To narrow down results even further, (effect OR impact OR influence) was added into the search yielding 38 results. To make the article review more manageable, (symptoms OR behaviors) was added to the search. This narrowed results down to 33. The Boolean operator NOT was then included to further narrow down the results. When NOT (adult) was added to the search, results narrowed down to 26. Next, NOT (methylphenidate) yielded 17 results. Finally, NOT (autism spectrum disorder) yielded a manageable 15 results. The keywords adult, methylphenidate, and autism spectrum disorder were

used to eliminate studies that included adult participants, focused on medication, or focused on disorders other than ADHD. From there, the abstracts of promising articles were reviewed.

All articles used in this synthesis met certain criteria for inclusion. Research was focused on a wide range of children including toddlers, preschoolers, school-aged, and adolescence. There is one exception; the qualitative study interviewed participants with a mean age of 22.7 years. However, this research was included because the questions asked during interviews were strictly about the participant's youth (i.e., experiences before the age of 18). The reasoning being that an adult would be able to better explain abstract concepts and feelings about their disorder than a child would. All research selected for this synthesis also included children diagnosed with ADHD or children who displayed behaviors associated with ADHD. A diagnosis of ADHD must have been given by a psychologist using standards set in the Diagnostic and Statistical Manual of Mental Disorders. Depending on the year research was conducted, the DSM-IV or DSM-5 may have been used as no changes were made in the 5th edition to any symptoms of ADHD. Some participants in the research may have been taking medication or may have been involved in behavioral therapy. That alone did not exclude research from this synthesis. Research was only excluded if the main form of treatment was medication or behavioral therapy rather than physical activity intervention.

Ten articles were selected for the literature review. Of the ten articles, one used mixed methods (i.e., qualitative and quantitative), six were quantitative studies, two were research reviews, and one was a qualitative study. Of the two research reviews, one included mixed methods studies while the other included quantitative studies. These articles were retrieved from the following journals: *Journal of Abnormal Child Psychology*, *Acta Paediatrica*, *Medicine & Science in Sports & Exercise*, *Child & Family Behavior Therapy*, *Child: Care, Health &*

Development, Adapted Physical Activity Quarterly, Physical Education and Sport Pedagogy, Perspect Psychiatr Care, Journal of Medicine and Life, and Indian Journal of Psychiatry.

Participants from the research used in this synthesis included male and female children ages 2 to 16 years old. This critical mass of studies included 802 children in addition to the 6 adults who were interviewed about their childhood. Of the 802 children,

632 were males and 107 were females. Children were in various grade levels ranging from preschool to high school. Data was collected and analyzed through interviews for the qualitative study, and the research reviews and quantitative studies collected data using surveys, questionnaires, rating scales, and instrumentation for physical activity. These included the Behavioral Rating Inventory of Executive Function (BRIEF), The Conners' Abbreviated Symptom Questionnaire-Teachers (ASQ-T), Conners' abbreviated rating scale – (CARS), ADHD-Rating Scale–IV (ADHD - RS IV), Clinical Global Impression (CGI)-Severity, Test of Gross Motor Development-2 (TGMD-2), Child Behavior Checklist (CBCL), Conners' Parent Rating Scale (CPRS), Polar FT1 heart rate monitor, and the Progressive Aerobic Cardiovascular Endurance Run (PACER).

Chapter 3 – Review of Literature

The purpose of this chapter is to review the literature on the effectiveness of physical activity intervention programs on reducing or eliminating behaviors associated with ADHD in children. This review will explore the various behaviors that are associated with ADHD (e.g., hyperactivity, impulsivity) as well as various forms of physical activity (PA) intervention including aerobic exercise, sports, and yoga. In particular, the following topics will be reviewed: physical activity implications, impact of physical activity on behavior and impact of physical activity on social and emotional well-being.

Physical Activity Implications

Recent literature in the area of ADHD intervention explores the use of physical activity intervention as a means of treatment for the behaviors associated with ADHD. Some studies focus mainly on core behaviors associated with ADHD such as hyperactivity, inattention, and impulsivity. Other studies focus on the social-emotional impact of ADHD and the impact PA intervention has on comorbid disorders such as anxiety and depression. PA intervention may serve as a possible treatment option in addition to a child's current treatment (e.g., medication). The studies reviewed will explore the possibility of PA as a possible sustainable and long-term treatment. If PA intervention proves to be effective in decreasing behaviors associated with ADHD and improving the social and emotional well-being of children, this may have implications for improvements in multiple domains of a child's life (e.g., social, academic, personal).

Impact of Physical Activity on Behavior

Recent studies have focused on various forms of physical activity intervention as a treatment method for reducing the behaviors associated with ADHD. Physical activity

intervention is typically recommended as a form of treatment in addition to more widely used treatments such as medication and cognitive behavioral therapy. Literature focuses on the use of sports, aerobic exercise, and yoga as forms of intervention.

Types of Physical Activity Interventions

Aerobic Exercise

Hoza, et al., (2015) conducted a study to examine the effects of aerobic physical activity on behaviors associated with ADHD in young children. Intervention duration was 31 min per day, each school day, over the course of 12 weeks. Subjects consisted of 202 students from kindergarten to second grade. Students were racially and ethnically diverse with 54% of participants being male. Participants were randomly assigned to either a physical activity (PA) group or a sedentary classroom (SC) group. Those assigned to the PA group engaged in moderate to vigorous physical activity while those assigned to the SC group participated in sedentary art projects. Data collection pre and post intervention included use of the PACER (Progressive Aerobic Cardiovascular Endurance Run) test, parent and teacher reports from the ADHD-IV Rating Scale, and the Oppositional/Defiant subscale of the Pittsburgh Modified Conners Parent and Teacher Rating Scale (PMC). Results indicated that PA intervention was more effective than SC intervention at reducing the ADHD associated behavior of inattention. In addition, aerobic exercise was effective in reducing moodiness in children.

Similarly, Burkart, Roberts, Davidson & Alhassan (2018) examined the effects of physical activity intervention on behaviors associated with ADHD in preschool aged children. 71 children ages 3-4 years old participated in this study. Children were randomized into a locomotor-based play intervention group and a free play group. Intervention included aerobic activities with various targeted locomotor actions (e.g., hopping, running, galloping).

Intervention lasted for 30 minutes a day, 5 days a week for 6 months. Baseline and post intervention data were collected using the 2nd edition of the Behavior Assessment System for Children (BASC-2) which included a teacher rating scale. Results indicated the locomotor-based play intervention was successful at reducing behaviors associated with ADHD when compared to the free-play control group. These behaviors included hyperactivity, inattention, and aggressive behaviors. Teachers also reported that post intervention, children displayed less disruptive behaviors in class. Authors concluded that PA intervention is a promising way to improve behaviors in the classroom.

In addition, in a systematic review and meta-analysis by Cerrillo-Urbina et al., (2015) studied the effectiveness of exercise interventions on behaviors associated with ADHD. These studies mainly focused on aerobic exercise. Behaviors including hyperactivity, impulsivity and inattention as well as cognitive functioning and anxiety (i.e., a frequent comorbid disorder with ADHD) were explored. Eight studies were reviewed with a total of 249 participants. All studies were randomized control trials including children diagnosed with ADHD from the ages of 6-18. Data collection for each study consisted of questionnaires and the Conners' Parent Rating Scale (CPRS).

After reviewing all eight studies, results indicated short-term aerobic exercise was effective in decreasing hyperactivity, inattention, impulsivity and oppositional behaviors as well as improvements in executive functioning. Authors concluded that long-term intervention is promising and should be explored. A small number of articles in this review explored yoga intervention. However, there was less evidence supporting the use of yoga compared to aerobic exercise. Authors concluded that yoga intervention improved participant's social skills and anxiety.

Although multiple studies have shown that aerobic exercise is a promising form of PA intervention in reducing various behaviors associated with ADHD, the use of yoga as PA intervention has been explored. Recent studies advocate for the use of daily yoga as a long-term treatment option for children diagnosed with ADHD to target reduction of inattention, impulsivity, and hyperactivity.

Yoga

Farahani, Hekmatpou, Khonsari, & Gholami, (2019), examined the effectiveness of super brain yoga exercises in reducing behaviors associated with ADHD in school-aged children. Baseline and post-intervention data for 80 participants (40 males, 40 females) ages 6 to 13 years were collected via a questionnaire and parent rating scale. The questionnaire contained demographic questions and questions about the child's history with ADHD. The Conners' Parents Rating Scale (CPRS) was used to assess behavioral changes in the areas of impulsivity, hyperactivity and learning difficulties such as inattention and memory. Super brain yoga included daily breathing exercises combined with acupressure. Intervention lasted for 2 minutes a day over the course of a month. It was suggested that this form of intervention may be sustainable long-term as it is easy to perform and can be implemented as part of a daily routine. Results of this study indicated an overall reduction in the severity of behaviors associated with ADHD following intervention. These behaviors included hyperactivity, impulsivity, intention, and conduct problems (e.g., impoliteness/aggression). While the decrease in severity of behaviors was the most notable result of this study, participants also reported increased self-esteem, less anxiety, better sleep, and less conflict in school which led to better peer relationships. Most notable was an increased ability to maintain attention and concentrate on material in class which has the potential to increase academic achievement.

In the recent literature, the use of yoga as a form of PA intervention for treating children with ADHD has the potential to be a long-term and sustainable treatment option for decreasing some of the core behaviors associated with ADHD. Less commonly explored than the use of aerobic exercise of yoga as PA intervention is the use of sports (i.e., individual or group).

Sports

Lufi and Parish-Plass (2011) conducted a study to determine if physical activity was beneficial for young boys with ADHD and other behavioral issues. 32 male participants, ages 8 to 13 participated in 20 weekly sessions of physical activity intervention for 90 minutes per session over the course of a single academic year. Children participated in individual sport activities such as obstacle courses or running and team games like soccer, basketball, or flag-football. Children also participated in group discussion about activities to encourage pro-social skill development. Data collection during baseline and post-intervention included using the Conners' Abbreviated Symptom Questionnaire-Parents (ASQ-P), Youth Self-Report (YSR), and Child Behavior Checklist (CBCL). Post-testing was completed one year after completion of the group. Participants indicated improvement in two behavior domains while their parents indicated improvement in five behavior domains. Results indicated an overall improvement for the following behavioral domains: anxiety, aggression, attention, delinquency, social, externalizing, and somatic. Externalizing behaviors are outwardly expressed (e.g., defiance) and the somatic domain includes physical symptoms. Overall, authors concluded that the decrease in behaviors was significant enough to lead to an increased quality of life.

Impact of Physical Activity on Social/Emotional Well Being

Besides the impact of PA on behaviors associated with ADHD, many recent studies have focused on the effects PA has on social/emotional well-being for children who are diagnosed

with ADHD. Physical activity intervention in the form of aerobic exercise, yoga, and sport have been explored as treatment options to improve anxiety, depression, peer-relationships, and self-esteem.

Aerobic Exercise

Verret et al., (2012) conducted a study to explore the effects of a physical activity program on the motor skills, cognitive functions and behaviors of children diagnosed with ADHD. 21 school aged children (19 males, 2 females) ages 7 to 12 years participated in a 10-week physical activity training program of moderate to high intensity aerobic exercise. Activities included a variety of object-control and locomotor tasks (e.g., kicking, throwing, jumping). Baseline and post-intervention data were collected using the Child Behavior Check List (CBCL). Results indicated participation in the PA program improved participant's cognitive functioning (i.e., greater memory processing speeds) and children displayed lower levels of inattention and impulsivity. Most notable was the positive impacts on participant's social and emotional well-being. Through data analysis of the CBCL, children experienced lower scores on the anxiety/depression scales of the assessment as well as a lower amount of social issues in school. Authors suggested that this form of PA intervention could improve appropriate social behaviors and social relationships.

In other findings, Kamp, Sperlich and Holmberg (2014) conducted a literature review to summarize research studies on the impact and beneficial effects of physical activity on ADHD in children. All five research articles selected in this review included 103 children (92 males, 11 females) ages 7 to 13 years diagnosed with ADHD who participated in physical activity intervention. Forms of intervention included low to high intensity activities involving aerobic exercise (e.g., exercise stations, ball games, tag) while one included yoga (i.e., meditation and

respiratory training). Lengths of intervention ranged from 20 minutes up to an hour and twice weekly to daily depending on the study. Duration of each study lasted anywhere from 1 week to 10 weeks. Baseline and post-intervention data was collected from daily logs kept by participants and various parent and teacher behavior rating scales.

Results showed that aerobic exercise improved children's appropriate social behaviors. Children displayed enhanced cooperation skills with others and this led to a decrease in social problems at school. Children were also observed to display less anxiety and fewer symptoms and behaviors associated with depression. Although improvements in social and emotional well-being were significant, some of that studies reported that aerobic exercise reduced behaviors associated with ADHD including hyperactivity, impulsivity, and inattention. Aerobic exercise was the main focus of this review but yoga was also shown to decrease anxiety.

Recent literature supports the use of aerobic exercise as PA intervention for improving the social and emotional well-being of children diagnosed with ADHD. Aerobic exercise may lead to reductions in inappropriate social behaviors which can positively impact a child's quality of life. In addition, yoga has been studied as a form of PA intervention for improving the social and emotional well-being of children who have ADHD.

Yoga

Hariprasad et al., (2013) explored the effects of yoga on children who have ADHD as a method of intervention. 9 participants (8 males, 1 female) included in this study were children ages 5 to 16 years diagnosed with ADHD. Participants were given ADHD rating scales pre and post intervention. These included the Clinical Global Impression (CGI), Conners' abbreviated rating scale (CARS), and ADHD-rating scale-IV (ADHD - RS IV). Intervention included a mandatory 8 yoga training sessions each lasting for an hour. After the 8 mandatory sessions,

participation levels varied based on participant willingness to continue intervention. Yoga sessions consisted of various forms of breathing exercises, OM chanting, postures, and loosening exercises. Children then were able to choose if they wanted to continue the daily yoga exercises at home for one to three months. The majority of participants continued performing daily yoga for two months but participation began to dwindle at three months. Parents indicated that lack of participation was due their child's disinterest or undisclosed family issues.

Results indicated that participants showed a significant improvement in behaviors associated with ADHD including hyperactivity, inattention and impulsivity. In addition, significant improvement in the domain of social/emotional well-being was noted. Results showed that intervention led to increased relationship quality with others and increased self-esteem. In addition, children and their parents noticed a decrease in anxiety and over all better quality of sleep. In school, children had less conflicts with others. Authors stated that no negative or adverse effects were noted as a result of yoga intervention. Follow up data from three months indicated that children who stopped all yoga exercise displayed a less significant decrease in behaviors than those who continued with daily exercises.

Daily yoga as a form of PA intervention for children who have ADHD is a promising method. However, results may depend on the child's level of interest in yoga. Another intervention option for improving the social and emotional well-being of children diagnosed with ADHD is participation in sports. Sports tend to be very pro-social activities and are often enjoyable ways for children to exert their energy.

Sports

Bustamante et al., (2016) conducted a study to explore effects of a 10-week after school exercise program for children with ADHD and/or disruptive behavior disorders. 35 children (24

males, 11 females) , ages 6 to 12 years old from grades K-8 were randomized into two different groups. These included an exercise program group with 19 children and a sedentary attention control group with 16 children. After school, both groups of children had time to eat a snack and complete homework before participating in 60 minutes of structured play time followed by unstructured playtime for 30 minutes. Children in the exercise group participated in competitive sports and cooperative physical activities. The control group completed sedentary activities art projects, puzzles, Legos, and board games. The Progressive Aerobic Cardiovascular Endurance Run (PACER) test, parent forms of the Behavior Rating Inventory of Executive Function (BRIEF), the Stop Signal Inhibition Task (STOPIT), the parent version of the Social Skills Improvement System (SSIS), the parent version of the Disruptive Behavior Disorder Rating Scale (DBDRS), and the Automated Working Memory Assessment System-Short Version (AWMA-S) were used to collect baseline and post-intervention data.

Results from this study indicated that compared to the control group, children in the exercise group displayed a decrease in hyperactivity after intervention. However, children in the control group displayed slightly higher performance on visuospatial working memory. Most notable was an increase in pro-social bonds from the students who participated in the intervention group. Parents indicated fewer social problems and an overall improvement in their child's mental health. Authors concluded that utilizing after school sports and physical activity games as a form of may increase the social and emotional well-being of children who have ADHD because this form of intervention may be seen as a leisure activity that can be sustainable throughout childhood.

Similarly, Homan, Causgrove and Holt (2014) conducted a study to explore the sport experiences of youth with ADHD by interviewing adults about their adolescent experiences with

team sports. Six adult males with a mean age of 22.7 years old diagnosed with ADHD during their childhood were interviewed in this qualitative study. Criteria for this study included that participants must have played three or more seasons in team sports during their adolescent years. All participants completed two semi-structured interviews where they were asked to reflect on their experiences. Participants reported that in their youth, ADHD encumbered their experiences and led to negative interpersonal and performance related consequences in and outside of school. Participants stated that participation in sports positively impacted their social skills and experiences, reduced stress levels, and served as an outlet for energy release. It was suggested that participation in sports mitigated the negative effects ADHD may have on a child's social and emotional well-being.

Summary

Overall, the studies selected for this literature review shed a positive light on the use of PA intervention for children diagnosed with ADHD. Studies did not suggest that the use of PA as a treatment to replace commonly used treatments such as medication and cognitive behavioral therapy. Instead, PA was recommended in addition to other treatment methods.

The main forms of PA intervention included aerobic exercise, sports (i.e., competitive or individual) and yoga. The majority of studies focused on aerobic exercise and/or yoga. Based on the reviewed literature, all forms of PA intervention resulted in reduction of behaviors associated with ADHD and/or improved social and emotional well-being.

Many of the reviewed PA intervention programs resulted in a decrease in behaviors associated with ADHD including hyperactivity, inattention, impulsivity, aggressive behaviors, and oppositional behaviors. In addition, some studies also noted improved social and emotional well-being. The most notable positive impact to emotional well-being post intervention was a

decrease in anxiety and depression. Studies also found that physical activity intervention encouraged pro-social behaviors and increased self-esteem. Overall, the studies in this literature review supported the use of PA intervention as a sustainable treatment method for children who have ADHD.

Chapter 4

Results, Discussion and Recommendations for Future Research

The purpose of this chapter is to present the results of the review of literature on the effectiveness of physical activity (PA) intervention programs on reducing or eliminating behaviors associated with ADHD in children and how these results align with the purported research questions which guided this synthesis project. In addition, recommendations for future research as it relates to PA intervention and children who have ADHD are presented. The results of this review of literature revealed the following; 1) effective forms of PA intervention include aerobic exercise, yoga, and sports 2) aerobic exercise, yoga, and sports are equally effective in overall reduction of behaviors associated with ADHD and 3) PA intervention shows promise as a long-term form of treatment for children who have ADHD.

Discussion

Interpretations

As part of this literature review, several research questions were posed. The first research question examined was, what forms of PA intervention are effective in reducing or eliminating behaviors associated with ADHD? Results of the reviewed literature indicated that overall, participation in PA intervention reduced various behaviors associated with ADHD. Across all 10 studies included in the literature review, this conclusion was unanimous. Many of these studies focused on the following behaviors: inattention, hyperactivity, impulsivity, and aggression.

Cerrillo-Urbina et al., (2015) found that out of 249 predominately male participants who completed forms of aerobic exercise as PA intervention, a significant decrease was noted in the following behaviors: hyperactivity, inattention, impulsivity and oppositional behaviors. In addition, improvement in executive function was noted. Improvement in the ability to focus and

the decrease in oppositional behaviors along with improved executive functioning may help students increase their academic performance as well. Other researchers had found similar results. Burkart, Roberts, Davidson & Alhassan (2018) found that out of 71 children who participated in locomotor-based PA intervention involving aerobic exercises, results indicated reduced hyperactivity, inattention, and aggressive behaviors.

Other studies focused on yoga intervention. Farahani, Hekmatpou, Khonsari, & Gholami, (2019) found that 80 children who performed daily super brain yoga exercises for a minimum of one month displayed decreased hyperactivity, impulsivity, intention, and conduct problems. Although not as extensively studied compared to aerobic exercise or yoga intervention, sports were also found to be an effective method of PA intervention. Lufi and Parish-Plass (2011) found that out of 32 participants who engaged in individual and group sports as a form of PA intervention over the course of one school year displayed decreases in aggressive and defiant behaviors as well as improved attention.

The second research question that was examined was, are certain forms of PA intervention more effective than others in reducing or eliminating behaviors associated with ADHD? The results of the reviewed literature indicated that various forms of physical activity intervention are greatly beneficial to children diagnosed with ADHD.

For instance, Kamp, Sperlich and Holmberg (2014) compared aerobic exercise to yoga and found that various studies including 103 participants reported improved appropriate social behaviors, enhanced cooperation skills, decreased social problems, decreased anxiety, and decreased depression following PA intervention. Results indicated that both forms of intervention resulted in significant decreases in behaviors associated with ADHD. Results did not differ significantly enough to indicate that one form of PA intervention was more effective.

Similarly, Cerrillo-Urbina et al., (2015) explored the effects of aerobic exercise and yoga as forms of PA intervention. Results indicated that the following core behaviors associated with ADHD were reduced: inattention, hyperactivity, and impulsivity. In addition, oppositional behaviors, anxiety and social issues were reduced. No statistically significant results were found that indicated one form of intervention was more effective in reducing or eliminating behaviors. However, results indicated that aerobic exercise resulted in a greater improvement in attention compared to yoga intervention while both aerobic exercise and yoga demonstrated similar reductions in hyperactivity and impulsivity. Yoga intervention resulted in greater improvements in oppositional behaviors when compared to aerobic exercise. Overall, both yoga and aerobic exercise were effective in reducing behaviors.

It should be noted that the use of aerobic exercise and yoga were more widely used as forms of intervention than sports in the current literature. However, the use of sports as a form of intervention yielded similar results to the use of aerobic exercise and yoga. For instance, Bustamante et al., (2016) found that the use of competitive and cooperative sports activities resulted in reduced stress and anxiety levels and positively impacted social interactions. Reductions in hyperactivity and impulsivity post intervention were also noted. Overall, this study found that the benefits related to stress, anxiety, and social interactions were greater than the reductions in core behaviors associated with ADHD (i.e., hyperactivity, impulsivity, inattention) even though reduction in core behaviors was noted .

The last research questioned that was studied was, is physical activity intervention sustainable as a long-term therapy treatment? Results from the reviewed literature suggest that PA intervention shows promise as a sustainable long-term therapy treatment. Cerrillo-Urbina et al., (2015) reviewed eight studies on the effectiveness of PA intervention on behaviors associated

with ADHD in children. Results of these studies indicated that PA is effective as a form of short-term intervention but it has the potential to be a sustainable long-term treatment option.

However, this is an area with limited exploration. Recent literature indicates that PA intervention is effective and can easily be implemented into a child's daily routine, but many studies range from only a few weeks to a year of intervention.

One exception is a study conducted by Homan, Causgrove and Holt (2014) that focused on youth sport experiences. In this study, adults who were diagnosed with ADHD in their childhood were interviewed and asked about their experiences with playing sports throughout childhood. Participants indicated that engaging in sports improved their social skills and positively influenced their educational and social experiences. In addition, they reported reduced stress levels and explained that sports served as a form of energy release. The use of sports as a form of PA intervention may be sustainable long-term.

Contrary to these results, Hariprasad et al., (2013) explored the effects of yoga on children who have ADHD. Eight yoga training sessions were mandatory but many children chose to continue their daily exercises for up to two months. By the third month, most participants were no longer completing their daily exercises. Parents reported that it became difficult to motivate their children to continue their exercises. This indicates that the type of PA intervention may impact the long-term sustainability. Motivation is a key factor and although a daily yoga routine did not take up much time and could easily be incorporated into a child's schedule, it was not motivating enough to continue long-term. On the other hand, engaging in sports proved to be very motivating and sustainable long-term.

Implications

After reviewing recent research in the area of PA intervention and children diagnosed with ADHD, similar conclusions were noted in multiple studies. The conclusions drawn from this synthesis are parallel to the conclusions drawn from similar studies. Based on the research gathered in this synthesis, PA intervention is an effective and beneficial method of intervention for children diagnosed with ADHD. Similar studies have also drawn the conclusion that PA intervention decreases behaviors associated with ADHD and improves children's social and emotional well-being. Research focused on aerobic exercise, yoga, and sports as forms of intervention. Data suggested that all forms of PA intervention were effective in reducing behaviors associated with ADHD. However, aerobic exercise typically resulted in greater improvements in attention, yoga resulted in greater decreases in oppositional behaviors, while sports resulted in greater improvements in social and emotional well-being rather than core behaviors associated with ADHD.

From the results found within all of the reviewed studies, it seems that they confirm existing theories on the use of PA intervention as a treatment option. Recent studies indicate that PA intervention decreases behaviors associated with ADHD including hyperactivity, impulsivity, and inattention. In addition, PA intervention improves the social and emotional well-being of children. Of the various forms of PA intervention studied, all forms were proven to be effective. Although various forms of PA intervention were found to be effective (i.e., aerobic exercise, yoga, sports), it is important to consider a child's motivation and allow them to choose which form of PA they want to participate in. This leads to increased enjoyment when participating in PA and that increased enjoyment may improve the long-term sustainability of treatment.

The practical implications are the use of PA intervention as an effective treatment option for ADHD in addition to the use of medication or behavioral therapy. No study included in this

review implied that PA intervention should replace the use of medication. Many participants in the reviewed studies were taking medication for ADHD in addition to participating in PA intervention. The correlation between physical activity intervention and the used of ADHD medication has not been extensively studied.

The success of PA intervention implies that improvements in behavior as well as social and emotional well-being may be strengthened if medication is not the sole form of treatment. For instance, the use of PA intervention can be enjoyable for children of all ages and it typically is not viewed as a “treatment” by children. It may be viewed as a leisure activity that can easily be incorporated into a child’s routine. In addition, medication does have side-effects and it can take a while to find the appropriate medication and dosage for a child. If children are currently experiencing negative side effects of medication or if they are in the process of beginning a new medication, the use of PA intervention may help with that transition.

Recommendations for Future Research

In reviewing the data base on the effectiveness of PA intervention programs on reducing or eliminating behaviors associated with ADHD in children, the following limitations were noted regarding the studies under review. Many studies included solely male participants or significantly more male than female participants. This may be due to the fact that males are three to four times more likely than females are to be diagnosed with ADHD (Cerrillo-Urbina et al., 2015). However, ADHD may present differently in females and their behaviors may not be comparable to those of male children. Another limitation was the duration of treatment in the reviewed studies. Results of these studies indicated that PA intervention has the potential to be a long-term form of treatment but no studies presented results past one year of intervention. This may be due to time constraints and concern over participant attrition.

In addition, one other notable limitation was that many of the studies included a mix of participants who were taking medication to treat ADHD and participants who were not. While PA intervention was not studied as a replacement for medication, it can be difficult to determine how medication effected the behaviors of participants and there are many factors that cannot be controlled. For instance, participants may not have been taking their medication regularly or they could have changed dosages or the type of medication. These factors could all impact behaviors.

Based on these limitations and other insights related to the literature the following recommendations for future research should be considered:

1. Further research is needed to establish the effectiveness of long-term treatment.
2. Research on female children with ADHD is warranted.
3. Future research should consider what ADHD medication participants use and the side effects of that medication.

Summary

Overall summary

The purpose of this literature review was to determine the effectiveness of PA intervention programs on reducing or eliminating behaviors associated with ADHD in children. The use of various delaminating variables in addition to focused research questions led to an extensive search for relevant studies to support this synthesis. 10 articles were selected for review. Results revealed that PA intervention reduced multiple behaviors associated with ADHD and improved social and emotional well-being. In addition, aerobic exercise, yoga, and sports were found to be effective in reducing behaviors associated with ADHD. The reviewed studies also supported the use of PA intervention as a short-term treatment option but stated that PA

intervention would be a promising long-term treatment method. Although further research is warranted to address limitations of current studies and expand our knowledge of ADHD and various forms of PA intervention, current research is promising. Data indicates that the use of PA intervention is a promising long-term treatment option that can be used in addition to medication in order to improve a child's quality of life.

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Appendix A

Author	Title	Source	Purpose	Methods & Procedures	Analysis	Findings	Recommendation Discussion & Notes
Hoza, Smith, Shoulberg, Linnea, Dorsch, Blazo, Alerding & McCabe (2015)	A Randomized Trial Examining the Effects of Aerobic Physical Activity on Attention-Deficit/Hyperactivity Disorder Symptoms in Young Children	<i>Journal of Abnormal Child Psychology</i>	To examine the effects of aerobic physical activity on ADHD symptoms in young children	Children were randomly assigned to either a physical activity group or a sedentary classroom intervention group and participated in the assigned intervention. Intervention duration was 31 min per day, each school day, over the course of 12 weeks.	Analysis included parent and teacher ratings of ADHD symptoms and mixed model ANOVA.	Physical activity intervention was more effective than the sedentary intervention at reducing ADHD symptoms of inattention and moodiness.	Inclusion of a non-treatment control group in future studies will enable further understanding of physical activity as an alternative management strategy for ADHD symptoms. This study supports the use of physical activity intervention in reducing behaviors associated with ADHD.
Kamp, Sperlich & Holmberg (2014)	Exercise Reduces the Symptoms of Attention-Deficit/Hyperactivity Disorder and Improves Social Behaviour, Motor	<i>Acta Paediatrica</i>	To summarize research studies on the impact and beneficial effects of various types of physical activity on ADHD in children.	Literature Review, comparing qualitative research studies that involved physical activity intervention programs. All participants were diagnosed	This literature review included articles from the following data bases: PubMed, MEDLINE and Sport-Discus that met set criteria for inclusion.	All research findings showed that exercise reduced the symptoms of ADHD and led to improvements in social behavior, motor skills, strength and neuro-	Incorporating exercise into children's daily routine may help improve the social and behavioral parameters of ADHD in children. This research supports the positive correlation

	Skills, Strength and Neuro-psychological Parameters			with ADHD and all interventions lasted for more than 5 days.		psychological parameters.	between physical activity and improving behaviors associated with ADHD.
Bustamante, Davis, Frazier, Rusch, Fogg, Atkins & Marquez (2016)	Randomized Controlled Trial of Exercise for ADHD and Disruptive Behavior Disorders	<i>Medicine & Science in Sports & Exercise</i>	To explore effects of a 10-wk exercise program for children with ADHD and/or disruptive behavior disorders.	19 children were randomized to an exercise program while 16 were placed in a sedentary attention control program. Cognitive and behavioral intervention outcomes were collected pre and posttest.	Cognitive and behavioral outcomes were collected pre and posttest. The CONSORT guidance was used during analysis.	Results indicated reduction in hyperactivity and impulsivity as well as improved verbal working memory and visuo-spatial working memory in children diagnosed with ADHD.	Authors recommend pushing for after school programs teaching time management and routines in addition to incorporating physical activity programs into children's routines. This research supports the use of physical activity programs in schools for improving academic performance as well as behaviors associated with ADHD.

Lufi & Parish-Plass (2011)	Sport-based Group Therapy Program for Boys with ADHD or with Other Behavioral Disorders	<i>Child & Family Behavior Therapy</i>	To determine if physical activity was beneficial for young boys with ADHD or other behavioral issues.	All participants participated together in 20 weekly sessions of physical activity intervention for the duration of 1 academic year.	Questionnaires completed as a post-test before the beginning of group, during the completion of the group, and a post-test 1 year after completion of the group. ANOVA was used.	Children indicated improvement in two behavior domains. Parents indicated improvement in their children's behavior in five domains. Anxiety was the biggest improvement.	Authors suggest that sport-based group therapy is beneficial for students that struggle with ADHD and other behavioral issues. This study mentions sports-based therapy rather than the use of general physical activity programs. However, there were only male participants.
Cerrillo-Urbina, García-Hermoso, Sánchez - López, Pardo-Guijarro, Santos Gómez & Martínez - Vizcaíno (2015)	The Effects of Physical Exercise in Children with Attention Deficit Hyperactivity Disorder: A Systematic Review and Meta-Analysis of Randomized Control Trials (RCT)	<i>Child: Care, Health & Development</i>	To examine evidence for the effectiveness of exercise interventions on symptoms of ADHD	Five databases (PubMed, Scopus, EMBASE, EBSCO [E-journal, CINAHL, SportDiscus] and The Cochrane Library) were searched for studies exploring the effects of physical activity intervention on symptoms of ADHD in	Meta-analysis of RCTs. Review Manager was used for calculation of confidence intervals and standardized mean differences.	Aerobic exercise had a moderate to large effect on symptoms of ADHD including attention, anxiety, executive function, and social disorders.	Incorporating short term moderate aerobic exercise into a child's routine as it seems to be effective for mitigating symptoms of ADHD. Different articles may focus on different forms of physical activity (e.g., yoga or sports). This article focused more

				249 children. The Methodological quality was assessed using the Cochrane tool of bias.			on yoga and aerobic exercise programs.
Homan, Causgrove & Holt (2014)	Youth Sport Experiences of Individuals with Attention Deficit/Hyperactivity Disorder	<i>Adapted Physical Activity Quarterly</i>	To explore sport experiences of youth with ADHD.	6 males with a mean age of 22.7 yrs. diagnosed with ADHD were interviewed in this qualitative study. They were questioned about their youth, criteria being that each participant must have played 3 or more seasons in team sports during adolescence.	All participants completed 2 semi structured interviews. Interpretive phenomenological analysis methodology was used.	Participants reported that Symptoms of ADHD in their youth hampered their experiences and led to negative interpersonal and performance related consequences. Participants also reported social and stress/energy-release benefits from sports experiences.	Having supportive coaches, understanding teammates, and personal coping strategies while playing sports will help with symptoms of ADHD. This is an interesting article because the participants were young adults. However, they reflected on experiences from adolescent years.

Hariprasad, Arasappa, Varamballay, Srinath & Gangadhar (2013)	Feasibility and efficacy of yoga as an add-on intervention in attention deficit-hyperactivity disorder: An exploratory study	<i>Indian Journal of Psychiatry</i>	To explore the effects of yoga on children who have ADHD as a method of intervention.	The 9 participants included children-adolescence diagnosed with ADHD. Participants were given ADHD rating scales pre and post intervention. Intervention included 8 yoga training sessions.	Analysis of scores obtained from pre and post assessments (i.e., CARS, ADHD-RS and CG).	Participants in this study showed a significant improvement in the behaviors associated with ADHD post yoga intervention.	The use of yoga training is a very feasible method of intervention that may act as an “add-on” to other forms of ADHD treatment. This article is not suggesting that physical activity be the main intervention method over other forms of therapy or medication.
Farahani, Hekmatpou, Khonsari, & Gholami, (2019)	Effectiveness of super brain yoga for children with hyperactivity disorder	<i>Perspect Psychiatr Care</i>	To determine how effective super brain yoga exercises are in reducing behaviors associated with ADHD in school-aged children.	80 participants (i.e., school aged children) practiced super brain yoga for 2 minutes a day over the course of a month. Data was collected via a questionnaire/parent rating scale pre and post intervention.	Data analysis consisted of descriptive statistics with the use of a paired t-test	Results of this study indicated a significant decrease in the behaviors associated with ADHD (e.g., conduct problems, hyperactivity, impulsivity, psychosomatic issues).	Practicing super brain yoga may help school-aged children reduce challenging behaviors that are associated with ADHD. Many research articles on this topic also focus on yoga as a form of physical activity intervention.

Burkart, Roberts, Davidson & Alhassan (2018)	Behavioral Effects of a Locomotor-Based Physical Activity Intervention in Preschoolers	<i>Journal of Physical Activity and Health</i>	To examine the effects of physical activity intervention on behaviors associated with ADHD in preschool children.	8 preschool aged children participated in this study. Children were randomized into a locomotor based play group and a free play group. Intervention lasted for 30 minutes a day, 5 days a week for 6 months.	Behavior assessment scales were used pre and post intervention. Statistical analysis (i.e., SSPS) was used to examine data.	Results of this study indicated that the locomotor based play intervention was successful at reducing the behaviors associated with ADHD.	Locomotor play based therapy is a promising intervention method. It is recommended for reducing problem behaviors that are associated with ADHD. This article is interesting because it focuses on preschoolers rather than school-aged students.
Verret, Guay, Berthiaume, Gardine & Béliveau (2012)	A Physical Activity Program Improves Behavior and Cognitive Functions in Children With ADHD: An Exploratory Study	<i>Journal of Attention Disorders</i>	To explore the effects of a physical activity program on the motor skills, cognitive functions and behaviors of children diagnosed with ADHD.	21 school aged children participated in a 10-week physical activity training program of moderate to high intensity. Data was collected through pre and post standardized testing.	Statistical analysis was used using ANCOVA and t-tests.	Results showed that participation in the physical activity program improved the cognitive functioning, motor skills, and behaviors of children who have ADHD.	Structured physical activity programs have clinical relevance for children diagnosed with ADHD. In addition to improving the behaviors associated with ADHD, physical activity can also improve motor skills and cognitive functioning.