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Original article

Parental perceptions of the effects of exercise on behavior in children and adolescents with ADHD

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Abstract

Background: Anecdotally, parents often report that children with attention deficit hyperactivity disorder (ADHD) who engage in regular physical activity (PA) experience positive behavioral changes. The purpose of this study was to examine this anecdotal relationship to provide preliminary evidence relevant to the potential benefits of PA on ADHD symptoms.
Methods: Parents ($n = 68$) of children diagnosed with ADHD completed an Internet survey assessing perceptions of how PA influences their child's symptoms.
Results: A significantly greater percentage of parents reported that regular PA positively impacted symptoms. However, there were no uniform effects for all types of ADHD symptoms. The results indicate that there may be more positive benefits for symptoms of inattention and hyperactivity than for those of impulsivity.
Conclusion: This is the first study to empirically document parents' perceptions of how PA influences ADHD and suggests that PA can be a viable strategy for reducing symptoms. PA may have greater benefits for specific symptoms of ADHD, providing critical information for developing PA interventions for children and adolescents.

Keywords: Attention deficit; Behavior; Pediatrics; Physical activity

1. Introduction

Attention deficit hyperactivity disorder (ADHD) is one of the leading childhood psychiatric disorders in America and is a costly major public health problem. ADHD affects approximately 3%–7% of school age children[1] and successful school outcomes for children with ADHD depend upon the degree to which treatment components meet the needs of a particular child. ADHD is characterized by age-inappropriate core symptoms of inattention, hyperactivity, and/or impulsivity which occur for at least 6 months in at least two domains of life, beginning prior to the age of 7 years.[1] These core symptoms persist into adulthood and can cause numerous impairments in a host of life domains. ADHD is most commonly treated through the use of stimulant medications, primarily methylphenidate (e.g., Ritalin) and amphetamines (e.g., Adderall). The second most common form of treatment is the use of behavioral interventions such as parent training and contingency management. Both pharmacological (e.g., stimulant medications) and behavioral interventions are effective in mitigating symptoms of ADHD,[2,3] however both have their limitations suggesting that research on alternative and/or complementary treatments is necessary. One limitation is that while both treatment types have proven efficacious in

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treating the core symptoms of ADHD in the short-term, there are few long-term benefits[3,4] and poor compliance rates.[5,6] An additional limitation of pharmacological treatment are side effects such as sleep disturbance, appetite suppression, headaches, and stomachaches, which all can negatively influence health outcomes and academic performance.[7]

Given that pharmacological interventions are not effective or viable options for some patients in managing their ADHD symptoms and that current behavioral treatments have limitations, the identification of other forms of treatment is warranted. Previous research has identified desirable characteristics of effective treatments which include that the treatment is socially valid and acceptable,[8] functionally based,[9] applied with a high degree of treatment integrity,[10] and has a benign side effect profile. Physical activity (PA) appears to fit these characteristics well and may be an effective adjunctive treatment intervention for ADHD. Anecdotally, parents and teachers often report that children with ADHD who are physically active experience positive changes in behavior patterns. However, PA has been relatively unexplored empirically as a behavioral treatment for children with ADHD.

The potential of PA as a treatment for ADHD is supported by the fact that PA has been found to positively impact many of the same neurobiological factors that are implicated in ADHD. An extensive body of evidence coming from animal models and recent studies with humans supports this statement. First, fMRI studies of individuals with ADHD show reduced cerebral blood flow and reduced activation in prefrontal and striatal areas of the brain for behavioral control tasks.[11,12] Animal models show that PA results in increased cerebral blood flow[13,14] and in human studies participants that are more aerobically fit show benefits in brain activity within regions associated with behavioral conflict and attentional control processes.[15] Additionally, PA increases the availability of dopamine and norepinephrine in synaptic clefts of the central nervous system.[16,17] These neurotransmitters play essential roles in attention, maintaining alertness, increasing focus, and sustaining thought, effort, and motivation. Consequently, albeit indirect, this evidence suggests the possibility that for children with ADHD, PA may be beneficial in reducing symptom severity.

Only a few studies have examined the impact of PA on ADHD and the focus has been on acute exercise and its effects on the hypothalamic-pituitary-adrenal axis[18] or dopaminergic responses.[19] Only one study has examined the impact of PA on behavioral symptoms in children with ADHD and results demonstrated that behavior, as measured by parent ratings on the Conners Parent Rating Scale, improved after a 5-week exercise program.[20] Further, no studies have explored the possible impact of chronic or regular exercise on behavioral symptoms of ADHD. Therefore the purposes of this study were two-fold. The primary purpose was to examine the anecdotal relationship between PA and ADHD symptoms to provide preliminary evidence for the benefits of regular PA in reducing ADHD symptoms. The second purpose was to collect qualitative data about parents' perceptions of the effects of PA on ADHD symptoms.

2. Materials and methods

2.1. Participants

Participants were recruited via email and Internet message boards affiliated with Children and Adults with Attention Deficit/Hyperactivity Disorder (CHADD) regional chapters in the month of September. The study was also posted on the CHADD website. In order to be included in the study participants had to be parents and/or guardians of a child or adolescent between the ages of 5−18 who had been diagnosed with ADHD by a medical professional.

Since this was a pilot exploratory study and we had a limited time frame of 1 month to collect data, we aimed to recruit 100 participants. A total of 96 participants completed the survey, however only 68 participants provided complete data and met the requirements of the study. The final sample consisted of 68 parents of children diagnosed with ADHD. Descriptive information for the children are summarized in Appendix. Based on parent report, all participants were previously diagnosed with ADHD by a medical professional. The majority of the sample (85%) reported using medication to treat ADHD.

2.2. Procedure and measures

This project involved using a web based survey to collect information from parents of children with ADHD relative to how PA impacts ADHD symptoms. The Internet survey assessed demographic information, ADHD diagnosis and history, PA participation and questions that obtained the parent(s) perceptions of how PA affects their child's ADHD symptoms. These questions were generated by the research team to assess perceptions of how PA influences their child's ADHD symptoms. These were exploratory and used for descriptive purposes. More specifically, parents were asked if when their child was physically active, they noticed a difference in ADHD symptoms broadly; in symptoms of inattention, hyperactivity, or impulsivity specifically; and in academic performance. If a difference was reported (participants marked "yes"), then they were asked to indicate how and whether the difference was positive or negative or both positive and negative. For example, to assess symptoms broadly the question stated: "Very broadly, have you noticed a difference in ADHD symptomology when your child is regularly involved in PA and/or organized community/school sports? If yes, please describe these differences. Are they positive or negative?" The same question format was used for symptoms of inattention, hyperactivity, impulsivity, and academics to create a total of five questions. For the purposes of this study, regular PA was defined as "activity that causes rapid breathing and fast heart beat for 30 consecutive minutes or more at least three times per week." This definition of regular PA was derived from the Physical Activity Questionnaire for Children and Adolescents (PAQ-C).[20] Participants were asked to indicate whether or not their children participated in regular PA by

checking yes or no to this question. The study was approved by the University's Institutional Review Board.

3. Results

Frequencies and percentages of the participants' responses to the survey items can be found in Table 1. If they answered yes to any of the five questions, they were asked to describe whether the effects of PA were positive or negative and to offer any details regarding the impact of PA. Chi-square goodness-of-fit tests were conducted to determine whether the responses were equally distributed.

3.1. Symptoms broadly

A chi-square goodness-of-fit test revealed that the yes and no responses were not equally distributed with a significantly greater number of participants reporting that PA impacted symptoms broadly in some way (X^2 (1, $n = 68$) = 5.88, $p < 0.05$). When asked to indicate whether the effects were positive, a significantly higher percentage (54.4%) reported positive effects of PA (X^2 (2, $n = 37$) = 51.05, $p < 0.05$) than negative (4.4%), both positive and negative (7.4%), or no (33.8%) effects. An example of responses from parents who thought there were only positive effects is: "He's calmer, less agitated. It wears him out. This is positive." "Definitely positive—much happier, more positive−great interaction with peers." "More focused, less anxious, better appetite, not as short of a fuse toward frustration, able to sleep better." An example of a response from a participant who reported negative effects of PA is: "Sometimes gets really loud and out of hand. Gets into people's spaces and is really clumsy." Additionally, participants reported both positive and negative effects with statements such as "Hyperactivity decreases a little after intense exercise. Impulsivity remains high."

Table 1
Frequencies and percentages of parent responses to survey items.

Item	Frequency	%
Symptoms broadly ($n = 68$)		
Yes, positive effect	37	54.4
Yes, negative effect	3	4.4
Yes, positive and negative effects	5	7.4
No effect on symptoms	23	33.8
Inattention symptoms ($n = 48$)		
Yes, positive effect	30	62.5
Yes, negative effect	0	0
Yes, positive and negative effects	3	6.3
No effect on symptoms	15	31.2
Hyperactivity symptoms ($n = 52$)		
Yes, positive effect	29	55.8
Yes, negative effect	3	5.8
Yes, positive and negative effects	2	3.8
No effect on symptoms	18	34.6
Impulsivity symptoms ($n = 54$)		
Yes, positive effect	16	29.6
Yes, negative effect	0	0
Yes, positive and negative effects	4	7.4
No effect on symptoms	34	63.0
Academic ($n = 60$)		
Yes, positive effect	38	63.3
Yes, negative effect	0	0
Yes, positive and negative effects	0	0
No effect on academics	22	36.7

3.2. Inattention

A chi-square goodness-of-fit test revealed that the yes and no responses were not equally distributed with a significantly greater proportion of participants (68.8%) reporting that PA impacted symptoms of inattention in some way (X^2 (1, $n = 48$) = 6.75, $p < 0.05$). When asked if PA impacted symptoms of inattention, responses were not equally distributed (X^2 (2, $n = 30 + 3$) = 18.93, $p < 0.05$) and significantly more participants (62.5%) reported positive effects. Some sample responses include: "Simply seems better able to remain on task (perhaps by 25%) if she gets regular physical exercise." "Positive. Able to focus better…if focus wains then we have had him run around the block or do something physical and then come back to the work." "Exercise or brief periods of activity during and after school allows him to be able to focus on his homework more easily…this PA seems to help him to control his body and focus easier in his classes."

Three participants (6.3%) reported both positive and negative effects: "This is tough—as I described above, it's both yes and no. Josh can have difficulty sustaining attention for games and needs engaged by a teacher or parent to stay focused, and yet I have seen that exercise can also at times increase his ability to focus."

3.3. Hyperactivity

A chi-square goodness-of-fit test revealed that the yes and no responses were not equally distributed (X^2 (1, $n = 52$) = 5.45, $p < 0.05$) with a significantly greater percentage of participants reporting that PA impacted symptoms broadly in some way (65.4%). When asked specifically about the effects of PA on symptoms of hyperactivity, the distribution of responses was significantly different from what would be expected due to chance (X^2 (2, $n = 29 + 3 + 2$) = 38.63, $p < 0.05$) with a significantly larger percentage of participants reporting positive effects (55.8%). Participant responses included: "I believe it puts him at a more level 'playing field' as other children." "He becomes more neutral in his level of hyperactivity." "…seems to be an outlet for energy, better esteem." "He is able to settle and focus better." Three participants reported that PA negatively impacted hyperactivity. For example, "A sport like soccer where it involves lots of running keeps his energy level up and makes him more likely to not be attentive and more likely to be excitable." Additionally, two participants reported both positive and negative effects such as "Sometimes positive, sometimes negative, sometimes activity can make him MORE

hyper…like he lost his breaks…most of the time though it is the opposite, he become less hyper."

3.4. Impulsivity

A chi-square goodness-of-fit test revealed participants equally reported that PA did or did not impact impulsivity (X^2 (1, $n = 54$) = 3.63, $p > 0.05$). Among participants that reported that PA did impact impulsivity, a significantly greater number reported positive effects (29.6%) than negative (0), both positive and negative (7.4%) or no effects (63.0%), X^2 (1, $n = 16 + 4$) = 7.20, $p < 0.05$. Examples of positive effects that were observed are: "He is more rational." "He will settle down easier after activity." "He doesn't seem to have the need to jump from one thing to the next. The exercise seems to neutralize his impulses." Several participants reported both positive and negative effects. One example comes from a participant who reported: "Sometimes positive, sometimes negative. He could kick a ball over a wall and impulsively go after it even though the other side is a highway, but then again as he is maturing or as the multimodal approach is working he is starting to back off of the impulsivity mid-stream."

3.5. Academics

A significantly greater percentage (63.3%) of participants reported positive effects of PA on academics (X^2 (1, $n = 60$) = 4.27, $p < 0.05$). The remaining 36.7% reported no effects of PA on academic performance. The following examples illustrate some beneficial effects reported by participants: "More successful because of the increase in blood to the brain…" "He seems to be able to focus better once outside playtime is over." and "There is no question that the balance of sports and activity helps (academic) performance. At times when he is 'on vacation' from organized sports and watches videos, TV or movies more he becomes less patient and more quickly frustrated." "On days that he has practice or a game, he does better at school the day of and usually the day after he is good as well."

3.6. Role of demographic and ADHD variables

To determine if sociodemographic or ADHD variables played roles in the relationship between PA and ADHD symptoms, chi-square tests were conducted. Results showed significant differences for ADHD type and academic performance, with more participants with a child that has combined type ADHD reporting that regular PA positively impacts academic performance ($X^2(3) = 4.68$, $p < 0.05$). Additionally, results showed that there was a significant difference between children taking medication and symptom differences, with more parents of children taking medication reporting positive differences from regular PA (69%) ($X^2(1) = 2.08$, $p < 0.05$). There was also a significant difference between children taking medication and academic performance, with more participants who had a child taking medication reporting a positive difference in academics with regular PA (67.9%; $X^2(1) = 4.12$, $p < 0.05$). There were no significant differences for age, gender, race, income, or year of diagnosis.

4. Discussion

This is the first study to provide empirical evidence documenting parents' perceptions of how PA influences ADHD symptoms. The findings suggest that PA is generally perceived as effective for mitigating behavioral symptoms in children diagnosed with ADHD. Although there were parents who perceived that PA had no effect on symptoms of ADHD, it is important to note that 85% of the sample was using pharmacological treatment for ADHD. In other words, most parents perceived that PA provided benefits beyond the benefits provided by the medications alone. This demonstrates the potential for PA to be used as a complementary intervention for ADHD that might have beneficial effects beyond that achieved through medication. These findings add support to arguments presented based upon underlying mechanisms which suggest that PA may be a viable behavioral strategy for reducing symptom severity.

With regards to symptoms at a general level, the majority of parents reported that regular PA positively impacted symptoms. However, there were no uniform effects for all types of ADHD symptoms. The results indicate that there may be more positive benefits for symptoms of inattention and hyperactivity than for those of impulsivity. A comment by one participant reinforces this: "If the activity is continually fast paced like soccer that seems to bring out the impulsivity because it's harder for him to control." While this may represent a limitation of PA to address impulse problems it may be that parents/guardians need to find the optimal sport and/or activity that will bring about positive changes in that domain. For example, team sports may not positively impact impulsivity; however an individual sport such as running or cycling may impact impulsivity more profoundly. Alternatively, individual sports such as running or cycling may not present the child with as many opportunities to engage in impulsive behavior due to the inherent nature of those activities. This is supported by evidence that children diagnosed with ADHD display higher levels of aggression and emotional reactivity in team sports compared to individual sports[21,22] and have difficulty following rules in team sports.[23–25] A secondary issue is that organized sport may not be the optimal way to bring about desired changes in behavior, rather engagement in PA and/or exercise may be more important. This is exemplified by participants who stated: "My son has a difficult time in organized sports—his coordination does not seem to be on par, and he is not as focused and driven as other children to succeed." or "There are times when he has a hard time following the rules of games at school in gym and staying focused." These comments reflect the possibility that organized sports present

challenges to children with ADHD that inhibit the benefits of PA on certain behavioral symptoms. Therefore it seems critical for future research to consider PA and/or exercise as separate from sport in order to optimally benefit behavior in children and adolescents with ADHD.

For the questions regarding symptoms broadly, academics, and hyperactivity there were considerable percentages of participants reporting that regular PA does not have an effect on symptoms. These can be interpreted positively in that they demonstrate that PA is not exacerbating symptoms. Another possibility for the reporting of "no effect" might be that parents have not thought about the connection between PA and academic performance and therefore are not able to answer the question adequately. This is supported by one participant's statement, "Not particularly…we'll have to pay attention to this (good question!)".

An additional point of interest is that these results are based on chronic PA patterns in children with ADHD which suggests the importance of examining chronic exercise treatment for ADHD rather than solely focusing on acute exercise. Since positive effects were perceived for regular PA, this suggests that finding ways to make PA a part of the daily lifestyle of children and adolescents with ADHD would be potentially beneficial. Also, it is important to note that regular PA impacted symptoms even though the majority of participants reported that their child was taking medication to treat ADHD. This is promising in that regular PA may be acting in conjunction with medication to contribute to the positive changes in a variety of symptoms and in academic performance in school.

This study has several limitations. First, we did not have an objective measure of PA, nor were we able to precisely identify the frequency, duration, or intensity of PA. Given that the goal of the study was not to examine the influence of specific PA variables on ADHD symptoms, we believe that the definition we used for regular PA was adequate to discern parent perceptions regarding the relationship between PA and ADHD symptoms. Another limitation of this research is that we used a broad age range of participants which limits the homogeneity of our sample. Finally, as with all survey data, the reliance on self-report for PA participation and symptom presence and severity means that these results should be interpreted with caution.

5. Conclusion

Overall, the results show that parents believe that PA positively impacts common symptoms of ADHD. These results support a recommendation that researchers empirically examine the potential effects of chronic exercise in ADHD populations. Because PA is a simple, widely available, and well-tolerated plausible intervention for many other clinical populations, it is likely to be a feasible activity for individuals with ADHD and preliminary evidence suggests that it may benefits symptom management in conjunction with pharmacological interventions.

Appendix.

Descriptive information for demographics of the sample ($n = 68$).

Parameter	Value
Age[a]	10.75 ± 3.52 (5−17)
Age at diagnosis[a]	6.79 ± 2.20 (2−13)
Height (in)[a]	56.83 ± 7.72 (41−76)
Weight (lbs)[a]	93.92 ± 44.99 (42−270)
Ethnicity[b]	
Caucasian	59 (86.8)
American Indian	1 (1.5)
Native Hawaiian/Pacific Islander	1 (1.5)
African American	7 (10.3)
Grade[b]	
1	7 (10.3)
2	2 (2.9)
3	10 (14.7)
4	5 (7.4)
5	9 (13.3)
6	6 (8.8)
7	9 (13.2)
8	5 (7.4)
9	5 (7.4)
11	2 (2.9)
12	8 (11.8)
ADHD type ($n = 63$)[b]	
Predominately hyperactive-impulsive	19 (30.1)
Predominately inattentive	11 (17.5)
Combined	33 (52.4)
Medication use[b]	
Yes	58 (85.3)
No	10 (14.7)
Combined family income ($n = 64$)[b]	
<$25,000	3 (4.7)
$25,000−$49,999	7 (10.9)
$50,000−$74,999	13 (20.3)
$75,000−$99,999	13 (20.3)
>$100,000	28 (43.8)

[a] Mean ± SD (range).
[b] Frequency (%).

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