

THE INFLUENCE OF PHYSICAL ACTIVITY PARTICIPATION AND
EXTERNALIZING BEHAVIORS AMONG CHILDREN WITH AND WITHOUT
ATTENTION DEFICIT HYPERACTIVITY DISORDER

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ABSTRACT

THE INFLUENCE OF PHYSICAL ACTIVITY PARTICIPATION AND EXTERNALIZING BEHAVIORS AMONG CHILDREN WITH AND WITHOUT ATTENTION DEFICIT HYPERACTIVITY DISORDER

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BACKGROUND: ADHD is brain disorder described by an ongoing pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development. One in every 20 children is affected by ADHD. **PURPOSE:** To examine the effect between physical activity participation and externalizing behaviors (conduct and hyperactivity) among children with and without ADHD. **METHODS:** The Growing Up in Ireland National Data set was used for analysis, only children with a diagnosis of ADHD were included ($n = 77$), and a gender-matched, random sample of children without ADHD for comparison purposes ($n = 77$). A Factorial ANOVA was conducted to compare the main effects of physical activity and the interaction effect between an ADHD diagnosis and physical activity on externalizing behaviors. The interaction effect (ADHD diagnosis X physical activity) was not significant, $F(1,138) = .011$, $p = .918$, demonstrating that the effect of physical activity on behavior did not significantly differ depending on the child having a diagnosis of ADHD or not. **DISCUSSION:** The findings of this study were consistent with other research.

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INTRODUCTION

Physical Activity and Physical Health

Several positive benefits to physical health have been identified as a result of physical activity, including improvements in blood lipids, decreased blood pressure, a lowered risk of being overweight/obese, and increased bone mineral density (Janssen & LeBlanc, 2010). Physical activity also improves risk factors associated with metabolic syndrome. A study in Denmark examined the association between metabolic syndrome and physical activity among 589 children, (average age of 9.6 years). The results demonstrated that physical activity is inversely associated with metabolic risk (Brage, et al. 2004). Another benefit of physical activity is a decreased risk of obesity. Nemet, Barkan, Epstein, Friedland, Kowen, Eliakim (2005) examined the effects of a physical activity intervention – biweekly exercise over a three-month period – on weight status among children aged 11.3 +/- 2.8 in the control group and 10.9 +/- 1.9 in the intervention group. Significant improvements were seen in BMI, body weight, and body fat percentage when compared to the control group.

Physical Activity and Psychological Health

In addition to providing physical health benefits, numerous psychological benefits have also been documented. For example, vigorous exercise has been associated with improved overall well-being, decreased anxiety, and lowered depression levels (Fox, 1999). Other findings show that physical activity relates directly to a higher overall

quality of life (Penedo & Dahn, 2005). The major psychological benefit of physical activity is a decrease in depressive symptoms. Aerobic exercise and resistance training may also be effective at lowering anxiety and may be effective at treating clinical depression, while simultaneously improving mood (Fox, 1999).

Research also demonstrates physical activity to provide a positive cognitive effect (Tomporowski, 2003) and improved behavior (Tomporowski, 2003). A study by Mahar, Murphy, Rowe, Golden, Shields, & Raedeke (2006) investigated the effect of physical activity on on-task behavior. The study had an experimental group that received a classroom based physical activity program, while the control group did not. The researchers found that the experiential group had a significant improvement on on-task behavior (E.S.=0.60 Moderate). Furthermore, a study examined classroom behavior for students receiving none to minimal recess with students receiving varied amounts of recess. Researchers found that the group of students receiving some form of recess generally had improved classroom behavior when compared to the group of students with none to minimal recess time (Barros, Silver, & Stein, 2009). The psychological benefits of physical activity are beneficial in many ways and warrant further examination (Berger, 1996).

ADHD

Attention Deficit Hyperactivity Disorder is a neurobehavioral condition that affects certain brain patterns (Zang Yu-Feng et al., 2006). The Diagnostic and Statistical Manual of Mental Disorders explains that ADHD is a persistent pattern of inattention

and/or hyperactivity-impulsivity that interferes with functioning or development with the symptoms are presented in two or more settings such as school, home, or work. ADHD negatively impacts social, academic, or occupation functioning (American Psychiatric Association, 2013). In order to be diagnosed with ADHD several symptoms must be present before age 12 (American Psychiatric Association, 2013). ADHD is linked to poor academic achievement, higher school suspensions, depression, aggression, and behavioral problems (Barkley, 1997). ADHD is consistent with frequent pairing of externalizing behaviors (Kuja-Halkola, Lichtenstein, D'onofrio, & Larsson, 2015). Children diagnosed with ADHD generally also meet the criteria for Conduct Disorder or Oppositional Defiant Disorder (Costello, Mustillo, Erkanli, Keeler, & Angold, 2003). Treatment for ADHD includes medication and behavior modification techniques (Loe & Feldman, 2007). It is estimated that four out of five children that are diagnosed with ADHD receive Special Education services (Loe & Feldman, 2007).

The trends are showing that the rise in the prevalence of ADHD is significant. A nationally representative sample of 3082 eight to 15-year-old children in the United States revealed that 8.7% of the children were diagnosed with ADHD (Froehlich, Lanphear, Epstein, Barbaresi, Katusic, & Kahn, 2007). From the data it was estimated that 2.4 million children aged eight to 15 in the U.S. have ADHD. In the U.S. it is estimated that ADHD affects one in every 20 children (Faraone, Sergeant, Gillberg, & Biederman 2003). A systematic review found that ADHD affects 5.29% of the population worldwide (Polanczyk, de Lima, Horta, Biederman, & Rohde, 2007). Geographical location doesn't seem to have an effect on the prevalence of ADHD and the prevalence of

ADHD is just as high in other regions of the world (Faraone, Sergeant, Gillberg, & Biederman 2003). A more recent study estimates the prevalence of ADHD at 7.2% worldwide (Thomas, Sanders, Doust, Beller, & Glasziou, 2015). In Ireland, a study investigated the prevalence of psychiatric disorders in adolescents, aged 12 to 15 years-old, found that among the sample (n=723), 3.7% were diagnosed with ADHD (Lynch, Mills, Daly, & Fitzpatrick, 2006). The prevalence in Ireland is of particular interest because the data for this current study will be taken from this country. Estimates of ADHD vary worldwide by study from 2% to 18% (Rowland, Lesesne, & Abramowitz, 2002), however, it is agreed that ADHD is the most prevalent psychological disorder of childhood (Ziereis & Jansen, 2015).

Physical Activity and Children with ADHD

Physical activity has shown to improve cognition (Tan, Pooley, & Speelman 2016) and enhance working memory in children with ADHD (Smith et. al., 2016). Aside from the benefits of physical activity on cognition in children with ADHD, the relationship between physical activity and behavior is of particular importance. Berwid & Halperin (2012) found that intense aerobic exercise might enhance neural growth and development, and improve behavioral functioning. In their study the experimental group conducted 30 minutes of vigorous exercise during two occasions and then were tested immediately after on a series of cognitive tasks. They found that exercised significantly benefited performance. In addition to this study, Verret, Guay, Berthiaume, Gardiner, & Béliveau, (2012) examined the effect of a ten-week intervention on a variety of outcomes for children with ADHD (n=21), including reports of on-task behavior. The intervention,

which consisted of three 45-minute sessions of physical activity over a ten-week period, resulting in a post-test significant difference for parents and teacher-reported total problems score and for three subscales: social problems, thought problems, and attention problems, as measured by the Child Behavior Checklist. The study presented evidence that physical activity may reduce hyperactivity in students with ADHD. Smith et al. (2016) found contrasting results when looking at children aged 5 to 9 with a diagnosis of ADHD (N=92). The intervention consisted of 15 weeks of Brain, Body, and Social Intervention. This included exercises ranging from simple to complicated movements with different requirements for reaction time, speed of processing, and hand-eye-body coordination for 45 minutes per session with 60 total sessions over the 15 weeks. The researchers found that behavioral outcomes were not affected based on this treatment (Smith et al, 2016).

Several pilot studies have found interesting results when examining ADHD and physical activity. One such study examined a sample of 17 children in grades kindergarten through third. The subjects participated in moderate to vigorous physical activity for 26 minutes daily over an eight-week period. The results showed that 64-71% of participants had significant or marginally significant improvements to motor, social, and behavioral functioning measures according to the post program reports (Smith et al., 2013). Additionally, another study that had a moderate to high intensity exercise program over a 10-week period found that participation in the program improved muscular capacities, motor skills, and behavior reports by parents and teachers](Guay, 2010). Other studies found similar results when examining intense exercise and behavior among

students with ADHD. Pontifex, Saliba, Raine, Picchietti, & Hillman (2013) found that a single 20-minute session of exercise increased regulatory processes for students with ADHD (n=20). When specifically examining attention, participants (N=66) ran at a high intensity for 5-minute relays. The researchers found that intense bouts of physical activity had a significant effect on attention at posttest.

To conclude, a systematic review on the effect of physical activity on youth with ADHD (Song Lauseng, Lee, Nordstrom, & Katch, 2016) examined 26 studies. The studies were grouped into two subcategories: those that did and did not account for effects of ADHD medications. The first category showed that these participants that were treated with ADHD medication had lower levels of physical activity, but improved cognitive and behavioral outcomes. The second category found a positive association between physical activity levels and cognitive and behavioral outcomes for children not treated with ADHD medications (Song, 2016). Physical Activity may improve behavior in children by increasing the ability to focus, lowering stress, and decreasing impulsivity (Song, 2016). Research focused on ADHD and physical activity is increasing, yet further research is required (Song, 2016). Further understanding of the effects of physical activity with students with ADHD may uncover further techniques in helping students with this condition and inform policy-influencing access to physical activity for this population.

Purpose

The purpose of this study is to examine the effect between physical activity participation and behavior among children with ADHD.

METHODS

On 4/26/2017 this study received IRB approval with the IRB number of 16-248.

Subjects

For this study data was utilized from the “Growing up in Ireland” (GUI) national study of 9-year-old children. The GUI examined a large range of factors based on children’s characteristics, experiences, and development. A sample of 8570 9-year-olds was taken from the national primary school system. The data was collected from questionnaires that were administered to the child, parents, teacher, and school principal. A total of 910 randomly selected schools participated in the study with children selected at random from those schools. Fifty-seven percent of the families agreed to participate with the response rate from the schools at 82%. For the purpose of this study, only children with a diagnosis of ADHD were included ($n = 77$), and a gender-matched, random sample of children without ADHD for comparison purposes ($n = 77$). Diagnosis was indicated by parental report.

MEASURES

Physical Activity

The physical activity of children was measured through the Leisure Time Exercise Questionnaire (Godin & Shephard, 1985) which was administered to parents. This self-report measure has demonstrated concurrent validity with measures of maximum oxygen intake (VO₂ max) and muscular endurance (Godin, Jobin & Bouillon, 1986), and acceptable test-retest reliability (Sallis, Buono, Roby, et al., 1993). Primarily the mother (or in the absence of the mother, the father) was asked how many times over the past 14 days their child had participated in at least 20 minutes of hard exercise. Hard exercise was defined as exercise that made the child breathe heavily along with the addition of their heart beating faster. A series of examples were provided such as playing football, jogging, and fast cycling. The scale used for physical activity over the past 14 days ranged from 1-5. 1 was assigned to no days with physical activity, 2 was one to two days with physical activity, 3 was three to five days with physical activity, 4 was six to eight days with physical activity, and 5 meant nine or more days with physical activity.

Behavior

Children's behavior was measured through the parental response to the Strengths and Difficulties Questionnaire (Goodman, 1997). The SDQ has demonstrated high validity (Goodman, 1997; Goodman & Scott, 1999) and reliability (Goodman, 2001; Haweas & Dadds, 2004). The instrument produces scores for each of five subscales: Emotional symptoms, Conduct problems, Hyperactivity/inattention, Peer relationship

problems and Prosocial behavior. For the purpose of this study, the ‘externalizing problems’ subscales –conduct and hyperactive symptoms – were combined (as suggested by Goodman et al., (2010)). The scores were based on a 3-point scale from 1 (not true), 2 (somewhat true), to 3 (certainly true). Examples of behavioral questions included: restless, overactive, cannot stay still for long; often has temper tantrums or hot tempers; constantly fidgeting or squirming.

Socioeconomic Status

Family social economic was determined by asking the mother (or in the absence of the mother, the father) what the household income (net after deductions of taxes and PRSI) is per year. Household income was then weighted to account for differences in size and composition of households in terms of the number of adults and children in the home.

Statistical Analysis

A factorial ANOVA was used to evaluate the effect of physical activity on externalizing behaviors. Main effects were examined for physical activity participation (participation in 9 or more days versus 9 or less days) and having an ADHD diagnosis or not. In addition, an interaction terms (ADHD diagnosis X physical activity participation) was examined to determine if the effect of physical activity on externalizing behaviors was different between individuals with and without ADHD.

RESULTS

Sample Characteristics

The study included a total of 154 participants: 77 children with ADHD and 77 TD children. Both groups comprised of 76% males (n=59). There was a significant difference in the mean income between the group with ADHD (M=16,480, SD=8,248) and the group without ADHD (M=22,421, SD=12,525); $t(144)=-3.394$, $p=0.001$.

Table 1. Sample characteristics

	ADHD (n = 77)	Without ADHD (n = 77)	T	Sig.
Gender: males: n	59(77%)	59(77%)		
SES M(SD)	\$16,480.40 (8,248.46)	\$22,421.42 (12,524.78)	.394	.001
SDQ Conduct M(SD)	3.87 (2.31)	1.19 (1.25)	8.951	<.001
SDQ Hyperactivity M(SD)	8.40 (1.89)	3.08 (2.47)	14.968	<.001
SDQ Externalizing Problems M(SD)	12.27 (3.47)	4.28 (3.00)	15.219	<.001
Physical Activity M(SD)	3.84 (1.33)	4.16 (1.113)	-1.578	.117

Physical activity

When examining the amount of exercise the groups had in the past 14 days, there was not a significant difference in scores for the group with ADHD (M=3.84, SD=1.33) and the group without ADHD (M=4.16, SD=1.11); $t(147)=-1.578$, $p=0.117$. When further examining the subjects that were active for nine or more days, there was not a significant

difference between the group with ADHD (n= 24) and the group without ADHD (n = 23), $p=0.727$.

Externalizing Behaviors

With the conduct and hyperactivity scales, significant differences were observed between groups, with the group with ADHD performing less favorably. There was a significant difference in scores on the SDQ Conduct subscale for the group with ADHD (M=3.87, SD=2.30) and the group without ADHD (M=1.19, SD=1.25); $t(117)=8.951$, $p<0.001$. There was also a significant difference on the SDQ Hyperactivity subscale, for the group with ADHD (M=8.40, SD=1.89) when compared the group without ADHD (M=3.08, SD=2.47); $t(140)=14.968$, $p<0.001$. The two scores of the SDQ's were combined to form the externalizing problems scale. There was a significant difference in the scores of the group with ADHD (M=12.27, SD=3.47) and the group without ADHD (M=4.28, SD=3.00); $t(151)=15.219$, $p<0.001$. The Null hypothesis that there would be no significant difference in externalizing behaviors between children with and without ADHD was rejected ($p < .001$).

Table 2. Factorial Anova Results

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	2296.737	4	574.184	38.346	.000
Intercept	2095.523	1	2095.523	139.946	.000
Equivinc	22.820	1	22.820	1.524	.219
ADHD Diagnoses	1820.282	1	1820.282	121.565	.000
Physical Activity 9 or More Days	123.512	1	123.512	8.249	.005
ADHD Diagnoses/Physical Activity 9 or More Days	.159	1	.159	.011	.918
Error	2066.382	138	14.974		
Total	11782.000	143			
Corrected Total	4363.119	142			

a. R Squared = .526 (Adjusted R Squared = .513)

A Factorial ANOVA was conducted to compare the main effects of physical activity and having an ADHD diagnosis, and the interaction effect between an ADHD diagnosis and physical activity, on externalizing behaviors. Prior to conducting a factorial ANOVA, the assumptions were checked. The dependent variable of externalized behavior was a continuous measurement (interval), while the independent variables were nominal. The normal distribution of the dependent variable was checked using a histogram to assure that the data was normally distributed. The sample size was sufficient (N=154) to meet the central limit theorem, which also implies that the data was normally distributed. The assumption of homogeneity of variance was violated, so the Mann-Whitney correction was utilized.

The main effect of ADHD diagnosis yielded an F ratio of $F(1,138) = 121.565$, $p = .001$, indicating a significant effect of having an ADHD diagnosis on externalizing

behavior. The main effect of physical activity was also significant, yielding an F ratio of $F(1,138) = 8.25, p = .005$, indicating a significant effect of physical activity participation on externalizing behavior. The second hypothesis that there would be no significant effect of physical activity on externalizing behavior was therefore rejected ($p=.005$).

The interaction effect (ADHD diagnosis X physical activity) was not significant, $F(1,138) = .011, p = .918$, demonstrating that the effect of physical activity on behavior did not significantly differ depending on the child having a diagnosis of ADHD or not. Therefore the last null hypothesis that there is no significant interaction effect between having an ADHD diagnose and being physically active on externalizing behavior was failed to be rejected ($p=.918$)

DISCUSSION

The primary purpose of this study was to examine the effect between physical activity and externalized behavior in children with ADHD in a sample of Irish nine-year-old children. This study found that children with ADHD had less physical activity than children without ADHD in the sample, although this was not statistically significant. Currently there exists a severe dearth of research on physical activity levels of youth with ADHD. However, Porrino et al. (1983) did measure physical activity levels of children with ADHD using accelerometers. They found that physical activity levels were significantly higher ($p=0.02$) for children with ADHD compared to the control. In contrast to parental questionnaires –as used in the current study –, Porrino used accelerometers, which may have reflected additional movements of children with ADHD including fidgeting. Furthermore, this study is quite dated and due to the differences in diagnostic criteria for ADHD (DSM III versus the current DSM 5) comparisons are difficult. There remains a severe lack of research on physical activity levels of children with ADHD. Future investigation on this subject is recommended and may give insight into recommendations of physical activity for children with ADHD.

This study showed that there were significant differences in externalizing behavior in the group with ADHD compared to the group without ADHD. On the externalizing problems scale (1-20) there was a significant difference in the scores of the group with ADHD ($M=12.27$, $SD=3.47$) and the group without ADHD ($M=4.28$, $SD=3.00$); $t(151)=15.219$, $p<0.001$. The results supported previous research that ADHD

is consistent with frequent pairing of externalizing behaviors (Kuja-Halkola, Lichtenstein, D'onofrio, & Larsson, 2015).

Regarding the effect of physical activity on externalizing behaviors, the results showed that there was a significant main effect of physical activity on externalizing behavior. The interaction term (ADHD diagnosis X physical activity) was not significant, suggesting the effect of physical activity on externalizing behavior does not differ depending on having an ADHD diagnosis or not. Among children with ADHD it was seen that scores on the SDQ scale were lower in children with ADHD who were receiving higher amounts of physical activity (9+ days) ($M=11.71$, $SD=3.93$) compared to children that were receiving less physical activity (less than nine days) ($M=12.74$, $SD=3.01$). This supports previous research showing that physical activity had a significant impact on decreasing externalized behaviors; for example, Berwid and Halperin (2012) demonstrated that intense aerobic exercise may improve behavioral functioning. Furthermore, the results were consistent with the study by Verret, Guay, Berthiaume, Gardiner, and Béliveau, (2012) who found significant differences in parental and teacher reports of on-task behavior during an exercise intervention. Various exercise interventions have been developed and show promise for increasing physical activity among children with ADHD, and thus improving cognitive performance and behavior. For example, Smith et. al (2016) found significant or marginally significant improvements to motor, social, and behavioral functioning in children with ADHD according to the post program reports. The results aligned with findings from the systematic review by Song (2016), who found a positive association between physical

activity levels and cognitive and behavioral outcomes for children with ADHD not treated with medications (Song, 2016).

Based on our findings schools should continue to incorporate physical activity into the school day. Not only did the findings show that behavior improved with more physical activity in children with ADHD, but also in children without ADHD. In order to promote functional classes with less instances of externalized behavior, schools should provide ample opportunities for students to be physically active. In addition, schools should also assure that physical activity programs are inclusive. Both acute/long term exercise programs have had significant impact on behavior by children with ADHD and have been shown to be positive in decreasing externalized behavior (Pontifex Saliba, Raine, Picchietti, & Hillman, 2013)(Guay, 2010). Future research should focus on the types of exercise to see if one type is more effective than another in decreasing externalized behavior. This is a research area that is relatively new and further investigation will help to understand physical activity of children with ADHD and externalized behavior.

Limitations

Although this research contributes to the lack of literature on physical activity levels of children with ADHD, and has several strengths including a reasonably large nationally representative sample, some limitations should be acknowledged. First, self-reporting can be subject to recall error and bias. Secondly, based on the sample size in this study, the use of accelerometers would not have been feasible, yet future studies could use a subsample to explore if the data aligns with parental reported data. Thirdly,

another limitation was the lack of information on disability and medication. Information such as severity levels or medication being used was not recorded. This is a large limitation to the study, because medication may have had a severe impact on the results. The final limitation was the type of exercise participated in by the children was not detailed. Knowing the specific type of exercise that the children were participating in could help to increase overall understanding and allow researchers to further isolate factors in future research.

CONCLUSION

Research is continuing to investigate physical activity levels and externalized behavior in children with ADHD. The results showed differences of externalized behavior in children with ADHD and physical activity, however the results were limited by parental reported data and the lack of specifics on the disability information. The current study contributes to the literature on this topic by being one of the few studies to investigate physical activity levels of children with ADHD and further investigates physical activity and externalized behavior. Future interventions to increase physical activity and decrease externalized behavior in children with ADHD should be examined.

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