The Association Between Physical Education and Symptoms of Attention Deficit Hyperactivity Disorder

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Objective: The purpose of the current study was to examine the association between structured physical activity, specifically physical education, and symptoms of Attention Deficit Hyperactivity Disorder (ADHD). Physical activity may be associated with lower levels of symptoms of ADHD and this rationale provided the impetus for the current study. Methods: A community-based, nationally representative sample of children from the Early Childhood Longitudinal Study, Kindergarten cohort (ECLS-K) was used. Structural equation modeling was used to examine the association of physical activity with symptoms of Attention Deficit Hyperactivity Disorder. Two random subsamples were drawn for the purposes of cross-validation of our model. Statistics reflecting model fit are reported. Results: With a standardized path coefficient value of –.23, findings from the current study indicate a significant, inverse association between physical education, as a structured form of physical activity, with the symptoms of Attention Deficit Hyperactivity Disorder in children. Conclusions: Using a community-based, nationally representative sample of children aged 5 to 7 years old from the United States, the results of the current study suggest that physical education, as a structured form of physical activity, may be considered as associated with lower levels of symptoms of ADHD across time.

Keywords: physical activity, ECLS, ADHD

Attention Deficit Hyperactivity Disorder (ADHD) has been reported as affecting approximately 1 in 20 school-aged children. This number is equivalent to having 1 child in every classroom across the nation having ADHD. In fact, ADHD is one of the mostly commonly diagnosed childhood psychiatric disorders. The symptoms of ADHD have been typically characterized by developmentally inappropriate levels of inattention, hyperactivity, and impulsivity that cause significant impairment in daily functioning. Needless to say, these symptoms that characterize ADHD can present challenges for children in school often translating into inappropriate behaviors such as difficulty taking turns, excessive talking, interrupting others, and excessive motor activity. The symptoms of ADHD have also been associated with poorer outcomes for children with ADHD as compared with their typically developing peers such as increased behavioral problems, higher likelihood of substance abuse issues, lower academic achievement, and higher rates of criminal recidivism.

The 2 most commonly implemented treatments for addressing these difficulties and challenges experienced by children with ADHD include drug or pharmacological therapy (eg, stimulants) and behavioral interventions. The use of drug treatment continues to be an issue of controversy in addressing the challenges faced by individuals with ADHD. This ongoing controversy has been aptly termed as the Ritalin wars. In fact, several studies have demonstrated that parental perspectives of drug treatment options are not consistently favorable. Efron, Jarman, and Barker indicated that many children had negative feelings toward medications while Doherty et al found that approximately half of their sample of children with ADHD reported that they would stop taking medication if provided the choice.

Regardless of the evidence that nonpharmacological treatments appear to be the preferred treatment option for many parents and children, medications, in the form of stimulants typically, continues to increase as a treatment option for ADHD. Therefore, it is imperative that effective behavioral interventions are identified that are easy to implement so that parents and practitioners may have a variety of options that suit their preferred treatment choices with respect to the child such as the inclusion of exercise. The link between low motor proficiency and ADHD has been well documented, but less research has investigated the effects of motor activity on the behavior related to ADHD. Exercise has been found to increase brain-derived neurotrophic factor (BDNF), which is associated with neurogenesis, or the generation of brain tissue. By enhancing the ability to encode, exercise such as methods employed in dance and movement therapy may also contribute to improvement in measurable behaviors like concentration, hyperactivity...
and impulsivity. Exercise has also been explored as a therapy to combat the mental fatigue related to ADHD. The attention restoration theory predicts that short doses of activity in nature, such as 20-minute walks, may be beneficial to the ability to sustain attention. Children exposed to walks in nature scored higher on a backward digit span test than children not exposed to the walks.

Physical activity may provide a means for improving physical health while also providing additional treatment benefits to children with ADHD. Research indicates that exercise could provide similar benefits to those provided by medication. Putnam suggests that the chemical or physiologic benefits of exercise are similar to those of pharmacological interventions, specifically in terms of possible increased catecholamine response. Additionally, as children with ADHD have been indicated as having poorer social skills as compared with their typically developing peers, research has suggested that sports activities may provide an outlet to improve these skills. In this sense, social skills instruction can act as a component of sports activities for children with ADHD. Gencoez points out that sport activities, as a structured form of physical activity, provide opportunities for social interaction for children. In addition, Hupp and Reitman suggest combining social skills training with sports skills training for maximum benefit.

While research has focused on the potential physical and social benefits of exercise and sports participation, other studies have examined the effects of physical activities on the symptoms associated with ADHD in more depth. For example, Ridgway et al compared the display of inappropriate behaviors including off-task behavior, inappropriate vocalizations, being out of one’s seat, and fidgeting among students with ADHD on days when recess was and was not provided. Ridgway et al found lower levels of inappropriate behaviors in the classroom on days in which a 10-minute recess was included in the students’ schedules. In addition, Reynolds, Nicolson, and Hambly found that an exercise program was associated with improvements in reading skills, specifically including phonological awareness, reading comprehension, verbal fluency, and semantic fluency, among participants having diagnoses of dyslexia, dyspraxia, or ADHD.

While research demonstrates some benefit of recess, such as lower levels of inappropriate behaviors in the classroom, as a form of unstructured physical activity, some experts have expressed concern about appropriateness of recess for children with ADHD. Radford and Ervin conducted a case study on a male child with ADHD and found that behavior problems, such as aggression and violence, were much more common in unstructured settings such as recess. Therefore, it may be more beneficial to determine the association of more structured physical activity on the symptoms of ADHD. This structured form of physical activity may not only reduce challenging behaviors associated with unstructured activities but it is likely that structured physical activity, such as physical education, would serve a larger range of children considering that recess is not age-appropriate for all individuals with ADHD. Furthermore, structured physical activity, such as physical education, may be more practitioner and school-friendly as being curriculum-based.

The purpose of the current study was to determine the benefits between a more structured form of physical activity, specifically physical education, and symptoms of ADHD. The current study examines whether physical activity may provide a similar refuge for children with symptoms of ADHD for managing and coping with their symptoms. Thus, the idea that physical activity may be associated with lower levels of symptoms of ADHD provided the impetus for the current study. As a result, the design of the current study was to develop a model that assesses the role of physical education, as a structured form of physical activity, on symptoms of ADHD and to cross-validate this model.

**Methods**

**Sample**

A sample of children from the Early Childhood Longitudinal Study-Kindergarten (ECLS-K), a longitudinal survey comprised of child assessments and responses from parents, teachers and school administrators, was used. The ECLS-K contains a community-based and nationally representative sample of children from the United States who began school during the 1998 to 1999 school year. The purpose of the ECLS-K was to provide comprehensive data that could be used to describe and to better understand children’s development and experiences in their schooling, as well as how their early experiences related to their later development, learning, and experiences in school. The multifaceted data, collected longitudinally, allow for the study of how various child, home, classroom, school, and community factors relate to cognitive and social development. The current study consisted of a sample of 17,565 children obtained from the ECLS-K database. The study followed a sample of children beginning kindergarten during the fall semester of 1998 to completing fifth grade in the spring semester of 2004. With the application of the appropriate weight, this sample of 17,565 students represents some 3,823,589 children across the nation beginning kindergarten in the fall semester of 1998. The sample consisted of an approximately equal number of boys and girls. With regard to ethnicity, 56.3% (n = 9891) of parents of the children described themselves as White, non-Hispanic while 14.2% (n = 2494) described themselves as African American and 17.4% (n = 2680) described themselves as being of Hispanic origin. Given that the law of large numbers can lead to the appearance of statistical significance, we randomly selected a 25% subsample resulting in a sample of 4391 children. A separate second subsample of children (25% of the sample) was randomly drawn for the purposes of cross-validation. Both samples revealed statistically similar (eg, nonsignificantly different) results, thus the results of the first model were reported.
Measures

All measures were obtained from the ECLS-K (NCES, 2006). To measure symptoms of ADHD, we used the same set of variables as Stevens and Mulsow24 to create our latent construct. From the method employed by Stevens and Mulsow,24 the latent construct consisted of 4 variables: 3 variables rated by teachers and 1 variable rated by parents; and requested that teachers and parents report using a 4-point frequency scale (ie, never, sometimes, often, and very often) of how often the child demonstrated a described behavior. The first of these variables rated by teachers was the approaches-to-learning composite, which assessed a child’s task persistence, flexibility, organization, eagerness to learn, learning independence, and attentiveness. The second of these variables rated by teachers was the self-control composite, which asked teachers to rate a student’s ability to control his/her behavior such as in controlling his/her temper and accepting the ideas and input from others. The last of these variables rated by teachers was the externalizing problem behaviors composite, which rated the frequency in which a student argues, fights, or has angry outbursts. The 1 parent-rated variable was the impulsivity and overactivity composite, in which a parent rated the frequency of fidgeting as well as hyperactive and impulsive acts.

To measure physical activity, we created a composite variable of physical education consisting of times per week and amount of time per day a teacher reported a child having received physical education. Physical education represents structured, curriculum-based physical activity for school-aged children. Thus, our measure of physical education does not include physical activity that may be considered unstructured such as recess or non-curriculum-based such as after-school sports or other activities that children may engage in. As such, the choice of our measures was dependent upon what variables were available from the ECLS-K. The ECLS-K consists of 6 time points of data collection beginning the Fall 1998 semester of the academic school year. Table 1 contains a diagram of all the variables used in the current study and the time points when data for these variables were collected as part of the ECLS-K study design. As such, Table 1 indicates that data were available on all of our variables of interest for the Spring 1999 semester of Kindergarten and the follow-up Spring 2000 semester of 1st grade. Thus, these data points were specifically used in our data analyses.

Procedure

All analyses were performed in MPlus (v. 5.20).25 Missing data for scores were analyzed using full information maximum-likelihood (FIML) as the method of estimation. As an extension of maximum likelihood, FIML takes advantage of all possible data points in analysis. Enders and Bandalos26 indicated that full information maximum-likelihood is superior to listwise, pairwise, and similar response pattern imputations in handling missing data that may be considered ignorable.

Analysis

Structural equation modeling was employed to examine the association between physical activity and symptoms of ADHD. Teacher-rated variables of the latent construct of symptoms of ADHD were hypothesized to be correlated with each other as compared with the 1 parent-rated variable. In our model, we constrained these teacher-rated variables to be correlated equally with one another. In performing our analyses, 4 statistics reflecting fit were reported: the chi-square ($\chi^2$) test statistic; the root mean square error of approximation (RMSEA); the Tucker Lewis Index (TLI), also known as the Non Normed Fit Index (NNFI); and the Comparative Fit Index (CFI) as appropriate. Our model was then cross-validated with the second, randomly drawn subsample.

Results

In evaluating model fit, the chi-square goodness-of-fit statistic was significant, indicating that the data may not fit the model, $\chi^2(31) = 17,876.96, P < .05$. The chi-square

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Note. X indicates data were collected on a selected variable at the selected time point.
statistic, however, has been indicated as being sensitive to sample size. The root mean square error of approximation (RMSEA) compensating for the effects of model complexity was 0.06, which according to Browne and Cudek\(^27\) indicates an acceptable fit of the model being less than or close to 0.05. As the model was saturated with 1 degree of freedom, model fit was perfect indicating a value of 0.985 for the Tucker Lewis Index (TLI), also known as the Non Normed Fit Index (NNFI) and a value of 0.986 for the Comparative Fit Index (CFI). Hu and Bentler\(^28\) note that fit index values of 0.95 (or better) are indicative of good fit. Figure 1 contains the path diagram for the association between physical education and symptoms of ADHD along with standardized path coefficient values.

After establishing model fit, the model can then be examined with respect to individual path values. All standardized path coefficient values were statistically significant at the .05 level or less. The correlational association between physical education during the Spring 1999 semester of kindergarten and the Spring 2000 semester of 1st grade was small with a standardized path coefficient value of 0.11. The correlational association between symptoms of ADHD during the Spring 1999 semester of kindergarten and the Spring 2000 semester of 1st grade was stronger with a standardized path coefficient value of 0.30. The association of physical education during the Spring 1999 semester of kindergarten as predicting symptoms of ADHD during the Spring 2000 semester of 1st grade was small to moderate and statistically significant with a standardized path coefficient value of −0.23. The value of this path indicates that as physical education, as a structured form of physical education increased for a child, that there was an associated decrease in the symptoms of ADHD. Table 2 contains the standardized path coefficient values for all paths not shown in Figure 1 including those paths from the latent variables estimated to observed indicators.

**Discussion**

Using a community-based, nationally representative sample of children from the United States, the results of the current study suggest that physical education, as a structured form of physical activity, is associated with lower levels of symptoms of ADHD across time. Our results are particularly important for parents and practitioners who wish to use alternative methods to treat the symptoms of ADHD as Wilson and Jennings\(^11\) have found that parents were often apprehensive about the use of medication in treating children with ADHD, citing fear that medication was overprescribed, as well as possible medication side effects, and a desire to have children learn to manage their behavior without medication. Understandably, Corkum, Rimer, and Schachar\(^29\) have reported that parents generally favored behavioral interventions over pharmacological interventions.

Parents and practitioners who seek nonpharmacological treatment options or who would simply seek another form of treatment for their child with the symptoms of ADHD in tandem with pharmacological treatment may consider structured physical activity such as organized sports and physical education as an option. Structured forms of physical activity such as physical education may provide an outlet for children with the symptoms...
of ADHD and subsequently be associated with lower levels of symptoms. Our results indicate that parents and practitioners should begin to consider structured forms of physical activity as possibly beneficial to a child with the symptoms of ADHD.30–32

While physical education may be considered associated with the lower levels of symptoms of ADHD, the mechanism by which physical activity is associated with lower levels of symptoms of ADHD, however, is unclear. A leading hypothesis has been physiologic in nature.16 This research suggests that the symptoms of ADHD are the result of a dysfunction in the cathecholamine system.16 Physical activity or exercise has been noted as a powerful stimulus of the cathecholamine system.16 Preliminary research has provided empirical support for this hypothesis.33 Otherwise, routine, structured physical activity may fatigue or tire children with ADHD producing a calming effect as a consequence of being physically active. Furthermore, structured physical activity may only preoccupy children with symptoms of ADHD but once the routine physical activity is discontinued, a child with the symptoms of ADHD may persist in their symptoms. In view of these concerns, we still consider structured physical activity as a relatively cost-effective means of intervention that is clearly associated with benefits to physical health and fitness. The possible benefits to physical health and fitness are particularly relevant in light of the growing epidemic of childhood obesity in the United States.34 In short, we do not consider there to be any negative effects associated with moderately-applied, structured forms of physical activity such as curriculum-based physical education or extracurricular organized sports activities for children with or without the symptoms of ADHD.

Future research should reexamine the association between physical activity and symptoms of ADHD with respect to pharmacological treatment. Combined pharmacological and behavioral treatments have been indicated as having the most benefit and better outcomes for children with ADHD over the use of either pharmacological treatments or behavioral interventions exclusively.35–38 We would hypothesize that children with the symptoms of ADHD who received combined pharmacological treatments and behavioral interventions such as a structured form of physical activity would have lower levels of symptoms of ADHD as compared with those children who received either form of treatment exclusively. Future research should examine this hypothesis with respect to structured forms of physical activity. Several limitations emerged as part of conducting the current study. The foremost limitation of the current study is that we had no information as to whether any of the children had a diagnosis of ADHD. We used a ‘symptoms of ADHD’ composite created in previous research that used a sample of children from the same ECLS-K database.24 Another limitation concerns the measurement of our construct of physical education as our data from the ECLS-K do not indicate the amount of time spent in physical activity but rather the time spent in physical education. Though physical activity would be a primary component of physical education, this limitation should be noted. In addition, self-report data (in this instance, parent- and teacher-reported data of ADHD symptoms) can be limited by insufficient recall and socially desirability on the part of

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the respondent.39 Barring these limitations, the results of the current study suggest that structured forms of physical activity may be viewed as associated with lower levels of symptoms of ADHD among a community-based, nationally-representative sample of children from the United States.

References