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ASSESSING THE MEDIATING EFFECT OF STUDENT PROBLEM BEHAVIOR ON THE RELATIONSHIP BETWEEN PHYSICAL ACTIVITY AND ACADEMIC ACHIEVEMENT IN THE INTERMEDIATE GRADES

A Dissertation in

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ABSTRACT

The purpose of this study was to examine the possible mediating effect of student problem behavior on the longitudinal relationship between physical activity and academic achievement in both third and fifth grade. Data were drawn from the National Institute of Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development (SECCYD; NICHD, 2010). Measures included physical activity accelerometer data, the Child Behavior Checklist (Achenbach, 1991), and the Woodcock-Johnson Psycho-educational Battery – Revised (Woodcock & Johnson, 1989). Analyses of the longitudinal relationships among these variables did not indicate direct or indirect relationships between overall levels of student physical activity and academic achievement. Exploration of the inclusion of prior achievement in the model addressed the need for researchers to include prior achievement when evaluating these relationships. Future research should address the necessity of introducing additional physical activity above and beyond what is typical within the school setting. Further evaluation of the most effective types of interventions to implement, and what outcomes to be measured, would benefit teachers, administrators, school psychologists, educators, and policymakers alike.

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CHAPTER 1

INTRODUCTION

The amount of time that children spend engaging in physical activity has been on the decline over the past 20 years (CDC, 2013). The American Heart Association (AHA) recommends that children engage in at least 60 minutes of physical activity each day; however, research has shown that only 42% of children and 8% of adolescents are meeting this goal (Barr-Anderson, AuYoung, Whitt-Glover, Glenn, & Yancey, 2011; Troiano et al., 2008). Despite these recommendations, television exposure has increased, resulting in a significant decrease in physical activity. Children watch more television and play video games in lieu of engaging in physical activities. Data collected from the Youth Risk Behavior Surveillance (YRBS; CDC, 2013) self-report survey indicated that approximately one-third of high school students nationwide report spending more than 3 hours each day watching television.[1] In 2013, approximately 43% of students reported spending 3 or more hours playing non-school related video games on a computer, up from 22% in 2003 (CDC, 2013). Data collected from the National Health and Nutrition Examination Survey (NHANES)[2] indicated that physical activity levels dramatically declined between childhood and adolescence. Whereas approximately 40% of children met the recommended 60 minutes of physical activity per day, only 8% of adolescents met this criterion (Troiano et al., 2008), and 15% of high school students do *not* participate in at least 60 minutes of physical activity on *any* day (CDC, 2013). This decline in the amount of time children and adolescents spend engaging in physical activity has prompted

[1] For more detailed information on the YRBS, visit http://www.cdc.gov/HealthyYouth/yrbs
[2] For more detailed information on the NHANES, visit http://www.cdc.gov/nchs/nhanes.htm

researchers to explore what this lack of physical activity may mean for student achievement and behavior.

Accountability, Academics, and Activity Levels

The increase in the accountability of schools to attain certain statewide educational requirements has led to an increased emphasis on academics. Unfortunately, this policy also has decreased the perceived importance of recess time and nonacademic classes such as physical education (Sallis, 2010). After the implementation of the federal No Child Left Behind Act in 2001, for example, approximately 44% of school districts in the United States increased time spent on reading and math by cutting programs like physical education, the arts, and recess (Pate et al., 2006; Sallis, 2010).

The School Health Policies and Programs Study (SHPPS; CDC 2014)[2], a survey conducted nationally by the CDC, assessed the amount of time students spent engaging in physical education (P.E.) classes as well as school-level requirements for physical activity. Only approximately 4% of elementary schools, 3% of middle schools, and 4% of high schools required daily P.E. classes for the entirety of the school year. More specifically, at the high school level, 52% of students did not attend P.E. once in a typical school week (CDC, 2013; CDC, 2014). Furthermore, only approximately 83% of high schools offered a daily recess, and approximately 55% offered intramural sports or clubs. Only 67% of high schools provided direct instruction on physical activity and physical fitness.

In response to these findings, a number of organizations (e.g., The Institute of Medicine, The National Alliance for Nutrition and Activity) have recommended that schools adopt daily physical education classes, daily recess in elementary school, and physical activity opportunities

[2] For more detailed information on the SHPPS, visit http://www.cdc.gov/shpps

before and after school (Pate et al., 2006). In addition, specific efforts have been put in place to attempt to mitigate this decrease in time spent engaging in physical activity throughout the school day. Recent school-based interventions have been aimed at assessing the efficacy of short activity breaks throughout instruction time to decrease students' inattention and hyperactivity. *Let's Move in School* was initiated by First Lady Michelle Obama to help combat childhood obesity through both nutritional and physical activity behavior changes. This program involves mobilizing the resources of the school, community, and parents (Coe, Peterson, Blair, Schutten, & Peddie, 2013). Various schools and programs throughout the United States have adopted *Instant Recess* (Yancey, 2010). This approach uses a combination of group dance and sports moves integrated into the normal school routine during times such as transitions between subjects or classes. Whitt-Glover, Ham, and Yancey (2011) found that *Instant Recess* increased students' on-task behavior by a statistically significant 11% (Active Living Research, 2013). The *Physical Activity Across the Curriculum* (PAAC) project found that classroom-based physical activity helped to both improve standardized test scores and lower increases in BMI as compared to schools with less time spent in active lessons (Active Living Research, 2013; Barr-Anderson et al., 2011; Donnelly & Lambourne, 2011).

Physical Activity and Academic Achievement

In 2008, the CDC conducted a review of four studies assessing the relationship between physical activity breaks, physical activity, and academic achievement, finding an overall positive relationship between physical activity breaks, physical activity, and academic achievement. (CDC, 2008). In 2010, the CDC conducted a more comprehensive review of 50 articles that assessed the relationship between physical activity, cognitive skills and attitudes, academic behaviors, and academic achievement. Physical activity included school-based P.E., recess,

classroom physical activity, and extracurricular physical activity. Cognitive skills and attitudes included self-esteem, attention, concentration, perceived academic or intellectual competence, and attitude toward school, amongst other related constructs. Academic behaviors consisted of classroom conduct and behavior. Academic achievement included grades on standardized tests and grade point averages. Of the studies that assessed cognitive skills and attitudes, half demonstrated a positive relationship, whereas half demonstrated no relationship. Of the studies that assessed academic behavior, the majority demonstrated no relationship between physical activity and academic behavior. Collectively, approximately 50% of the associations between different types of physical activity and academic achievement (both experimental and non-experimental studies) were positive while approximately 48% of the associations were not significant (CDC, 2010).

It is important to note that only one study included in this review (CDC, 2010) found a significant negative relationship between physical activity and academic outcomes. This review did not make broad conclusions of overall effect size, as a heterogeneous sample of studies was utilized, making comparisons and summaries problematic. While studies included did report moderate to large effect sizes, not enough studies analyzed the same variables in a given category to allow for drawing overarching conclusions about the magnitude of the associations between physical activity and academic achievement variables. Overall, an increase in the amount of time spent in physical activity during the school day appeared to either have a positive influence on achievement or no effect; time spent in physical activity in lieu of academic-related activities did not appear to negatively influence achievement.

A more recent literature review by Barr-Anderson and colleagues (2011) specifically explored the effects of introducing a variety of physical activity interventions in both the school

and work settings. Studies included in this review were either quasi-experimental (pre- and post-test), randomized control trials, or uncontrolled (pre- and post-test). Eleven of 17 studies evaluating the effect of physical activity interventions in the school setting on academic outcomes found significant positive effects in at least one area (achievement, knowledge, concentration, or on-task behaviors). This review did not differentiate between intensity of physical activity, as the majority of studies included evaluated physical activity via self-report or use of a pedometer.

While Barr-Anderson et al. (2011) assessed physical activity in multiple settings and its effect on a variety of outcomes, Kibbe and colleagues (2011) reviewed 11 studies that implemented Take 10! or PAAC (Physical Activity Across the Curriculum; a modification of Take 10!) at the school level over the past 10 years. Physical activity was measured via self-report in some of the studies; others utilized physical activity monitors. When measured by physical activity monitors, researchers found that physical activity levels during Take 10! were significantly greater than activity levels during P.E., lunch, or after-school activities (though not significantly different from activity during recess). Students in physical activity interventions showed practically significant improvement in reading and math achievement in the majority of studies. Furthermore, a reduction of 20% in fidgeting was observed in one study following implementation of Take 10! (Metzler and Williams, unpublished data, 2004; as cited in Kibbe et al., 2011).

Included in this meta-analysis was a randomized control trial conducted by Donnelly and colleagues (2009) evaluating the effects of PAAC in the schools. PAAC differs from Take 10! or Energizers in that physical activity is integrated in the curriculum, as opposed to specified activity breaks. PAAC implements 90 minutes per week of moderate-to-vigorous physical

activity intertwined with existing academic instruction. Twenty-four schools were selected, and 14 randomly received the PAAC curriculum while the 10 other schools served as controls. Implementation of PAAC began in second or third grade at baseline, and was completed by fourth or fifth grade, depending on when the curriculum was adopted. Students were then administered the Wechsler Individual Achievement Test – Second Edition (WIAT-II) following the completion of PAAC. Student academic achievement (reading, math, and spelling) in the PAAC schools showed significantly greater improvement as compared to students' achievement in schools that did not receive this intervention.

Physical Activity and Problem Behaviors

Though research is mixed, overall physical activity has been shown to be associated with mental health. Physical activity is viewed as a natural antidepressant, as it releases endorphins that help to alleviate mild to moderate depression (Ernst, Olson, Pinel, Lam, & Christie, 2006). Some studies have found no relationship between physical activity and mental health, whereas others have found moderate to strong support **(**Ahn & Fedewa, 2011; Biddle & Asare, 2011). Specifically, research on internalizing (e.g., anxiety and depression) and externalizing (rule-breaking problems, aggression) problem behaviors has tended to support an inverse relationship between physical activity and problem behavior, such that higher levels of physical activity tend to be associated with lower or decreasing levels of problem behavior **(**Ahn & Fedewa, 2011; Biddle & Asare, 2011).

In order to explicate the mixed research on the relationship between physical activity and mental health, the CDC conducted a review of existing literature (Physical Activity Guidelines Advisory Committee, 2008). Studies included in this review were limited to prospective cohort studies and randomized control trials. The findings of this review indicated that physical activity

does provide protective qualities against various aspects of mental health. Specifically, physical activity protects against the onset of symptoms of depression and reduces the symptoms of anxiety. Studies included in this review consisted of more than 100 population-based, cross-sectional observational studies with approximately 190,000 participants. This review found that active people in the United States, on average, were approximately 45% less likely to develop depressive symptoms as compared to their inactive counterparts. National prospective cohort studies found the odds of developing depressive symptoms to be approximately 25-40% lower in active people as compared to inactive people. Even after controlling for various risk factors (e.g., age, sex, race, income, etc.), the odds of active people developing depressive symptoms were 15-25% lower than inactive people. Moreover, participation in physical activity programs (randomized control trials) has been found to significantly reduce depressive symptoms in healthy adults and those already diagnosed with depression, regardless of gender, age, ethnicity, or medical condition.

More specifically, this review conducted by the CDC (2008) looked closely at the potential beneficial effects of physical activity for youth outcomes. Patterns of findings closely mirrored those in the adult population. Cross-sectional studies found negative relationships between physical activity and/or sports participation and depression, anxiety, and positive relationships between self-esteem or self-concept. Both randomized control trials and quasi-experimental studies found significant effects of physical activity on these outcomes. The Physical Activity Guidelines Advisory Committee (2008) also evaluated differential effects associated with types of physical activity and which activities produced the greatest benefit to overall outcomes for children and youth. Regular participation in resistance exercise, vigorous

aerobic exercise, and/or weight-loading activities for 3 or more days per week demonstrated the best results.

Though research is limited, externalizing problems (e.g., rule-breaking behavior, aggression) have tended to be inversely related to physical activity, such that higher levels of physical activity are associated with lower or decreasing levels of problem behavior (Biddle & Asare, 2011). Kirkcaldy, Shephard, and Siefen (2002) conducted a cross-sectional survey with approximately 1,000 German adolescents. This study examined the relationships among physical activity, social behavior, anxiety-depression, trait addiction, and smoking and drinking behavior, among others. Adolescents with higher levels of participation in physical activity had less social problems, as compared to less active adolescents. Social problems were assessed via the social problems subscale of the German version of Achenbach's Child Behavior Checklist (CBCL; Achenbach, 1991). Adolescents who never participated in endurance sports had significantly higher mean levels of social problems as compared to those who seldom, often, or frequently participated in an endurance sport.

Problem Behaviors and Academic Achievement

Regardless of levels of student physical activity, a relationship has been shown to exist between externalizing behaviors and academic achievement, and some support for a relationship between internalizing behaviors and academic achievement. Hinshaw (1992) conducted a review of empirical articles that explored the relationship between externalizing behaviors and academic achievement. Overall, a negative relationship was found between externalizing behaviors and academic achievement in adolescence. In younger children, inattention and hyperactivity were inversely related to academic achievement. Hinshaw emphasized that a variety of underlying factors (e.g., SES, IQ) need to be taken into account when exploring the

relationship between externalizing behaviors and academic achievement. While this review addressed the impact of externalizing behaviors on students' academic achievement, internalizing behaviors were not addressed.

Nelson, Benner, Lane, and Smith (2004) conducted a cross-sectional study examining the relationship between both internalizing and externalizing problem behaviors and academic achievement. Overall, they found that students with emotional or behavioral disturbances exhibited greater academic deficits as compared to typically developing peers. More specifically, students with externalizing problem behaviors had greater academic achievement deficits as compared to students with internalizing problem behaviors. A particular strength of this study was use of data for students in grades kindergarten through twelfth grade; however, this study was conducted using a limited sample size ($N = 155$) of students receiving special education services for emotional and/or behavioral disturbances. This study controlled for age of onset, but it did not include prior achievement.

Breslau et al. (2009) conducted a cohort study wherein they gathered teacher ratings of 6-year-old students' internalizing and externalizing problem behaviors on the CBCL (teacher rating form) and regressed these scores on subsequent academic achievement (WJ-R) at age 17. IQ was included as a covariate; however, prior academic achievement scores were not available. Although they found significant negative correlations between both internalizing and externalizing problem behaviors and academic achievement, these relationships were no longer significant when students' attention was taken into account.

Conclusions and Rationale

While a link may exist between physical activity and academic achievement, the specific mechanism behind this relationship is somewhat unclear. Many studies have evaluated attention,

self-esteem, and/or on-task behavior, but few have addressed student problem behaviors. Thus, inclusion of measures of student internalizing and externalizing problem behaviors could lend further insight into a potential mediating relationship between student physical activity, problem behaviors, and academic achievement. Moreover, research on the effects of physical activity on problem behaviors is mixed. Some research has lent support to the significant protective and positive effect that physical activity can have on depression and anxiety (e.g., Ahn & Fedewa, 2011; Biddle & Asare, 2011), whereas other, less recent, studies have found no significant relationship between physical activity and either internalizing or externalizing problem behavior in the intermediate grades (e.g., Hinshaw, 1992). Limited current research exists that explores the effect that both internalizing and externalizing problems might have on academic achievement. Furthermore, many prior studies have included a variety of covariates within their analyses (e.g., IQ, attention, gender, etc.), but few have included or had access to previous academic achievement. Inclusion of multiple time points, specifically third grade academic achievement as a covariate, is a unique extension of much of the current research.

Physical Activity, Problem Behavior, and Academic Achievement

While many prior studies have focused on physical activity outcomes, few individual studies have included all three of the constructs included in the present study. When evaluating these relationships individually, some significance has been found between physical activity and academic achievement, physical activity and problem behaviors, and/or physical activity and academic behaviors (e.g., Biddle & Asare, 2011; Donnelly et al., 2009; Nelson, Benner, Lane, & Smith; 2004). While relationships have been found between physical activity and academic achievement, the nature of these relationships is often unclear. Specifically, no studies to date

have examined if these pathways are mediated by other variables, such as student internalizing and externalizing problem behaviors, using the variables in the present study.

The focus of the proposed study was to examine the relationships among student physical activity, problem behaviors, and academic achievement in a single, integrated model across two different time points. Given this collection of questions and hypotheses, the model depicted in Figure 1 below was examined. The inclusion of two different time points allowed for exploration of potential bi-directional relationships between physical activity and internalizing and externalizing problem behaviors.

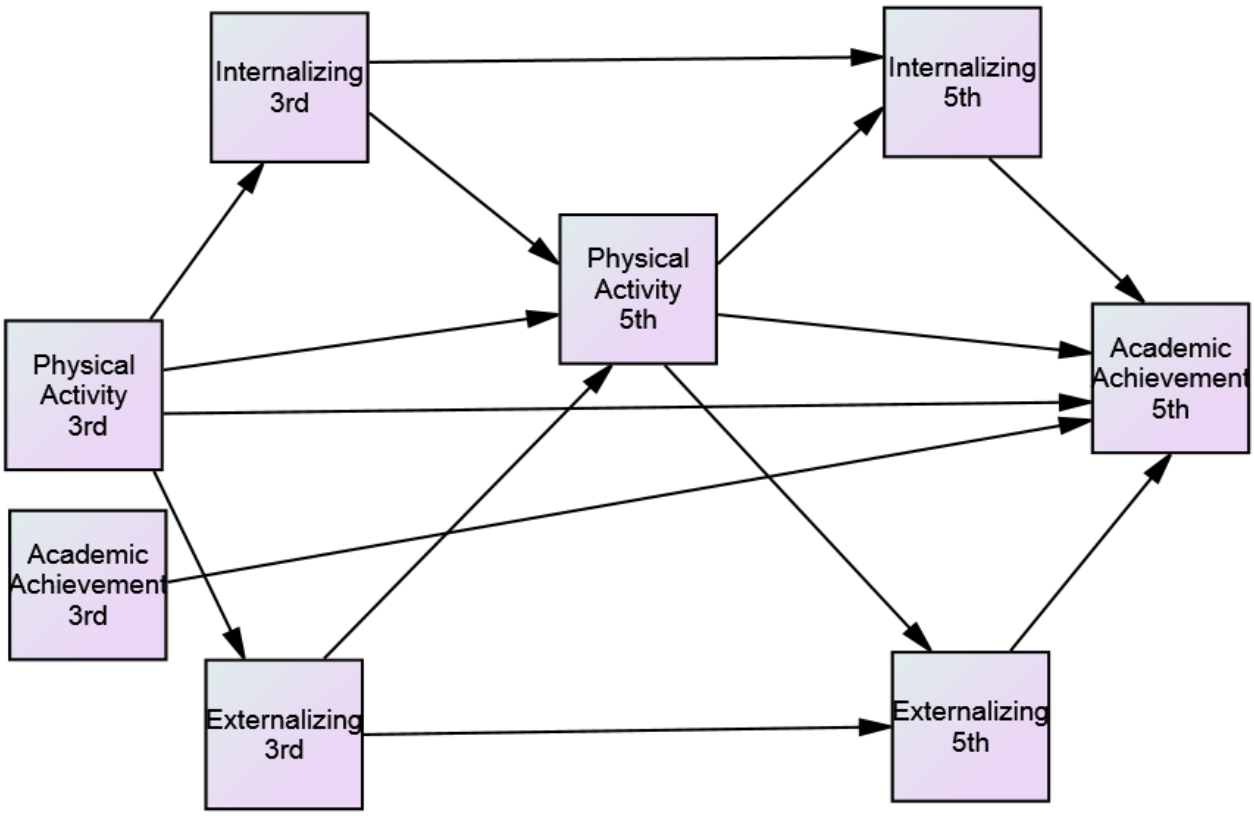

Figure 1. Model of the Hypothesized Mediation Relationship Between Physical Activity, Problem Behavior, and Academic Achievement in the 3rd and 5th grades.

Research Question

Research Question #1. What is the nature of the relationship between students' overall level of physical activity, problem behavior, and academic achievement across the intermediate grades?

Hypotheses

Hypothesis 1. There is a negative relationship between student physical activity and student problem behavior within the intermediate grades.

Hypothesis 2. There is a positive relationship between student physical activity and academic achievement within the intermediate grades.

Hypothesis 3. The relationship between student physical activity and academic achievement is mediated by student problem behavior.

CHAPTER 2

METHODOLOGY

Participants

Data for the present study were drawn from the National Institute of Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development (SECCYD; NICHD, 2010). This longitudinal study followed the development of children from 1 month to 15 years of age, and participants were recruited from 10 different university-affiliated data collection sites across the United States. The SECCYD included four phases based on the age or grade of the participants. The present study focused on Phase III, which included 1,061 participants in the second through sixth grades. In the original data set, 58.8% of mothers were married and 62.5% of homes included two adults. Approximately 60% of mothers were working, with income to needs ratio $M = 4.39$, and a total family income $M = 77{,}008$. Approximately 69% of families did not receive public assistance (i.e., food stamps). Demographic data in the final dataset were similar to that of the original data set. Data were collected via home and childcare visits, in school, and in the laboratory playroom. Annual health and physical assessments were also conducted in Phase III.

Measures

Measures used in the present study were administered during Phase III (i.e., third and fifth grade) data collection of the SECCYD. Data were collected via laboratory visits, home visits, physical activity monitors (accelerometers), and questionnaires completed by caregivers and teachers. Additional information on the measures used in the present study can be found in the Phase III Instrument document.[3] The following measures were used: (a) Physical Activity

[3] For more detailed information on the SECCYD visit http://www.nichd.nih.gov

Data, (b) The Child Behavior Checklist (Achenbach, 1991), and (c) the Woodcock-Johnson Psycho-educational Battery – Revised (Woodcock & Johnson, 1989).

Physical Activity. Accelerometer data provides an accurate, objective measure of student physical activity. Self-report of physical activity tends to be somewhat biased, in that individuals tend to overestimate the amount of physical activity engaged in (Troiano et al., 2008). For example, Trost et al. (2002) found discrepancies between accelerometer data rates of physical activity as compared to self-report data. Given these findings, physical activity data were collected via an accelerometer (CSA) worn by students on their waistband over a period of 7 days during the school year. A complete day of physical activity was defined as beginning after the first nonzero physical activity monitor (PAM) count after 5 a.m. up until one of the following criteria were met: (a) 60 consecutive minutes of zero counts after 9 p.m.; (b) 30 consecutive minutes of zero counts after 10 p.m.; or (c) the last nonzero count prior to midnight, whichever came first. Once the number of minutes for any given day were calculated, the total number of PAM counts was computed. Any invalid days of PAM data were removed from the dataset. This PAM collected student movement data and categorized it by activity level: Moderate (3-5.9 mets), Vigorous (6-8.9 mets), and Very Vigorous (> 9 mets). Mets were calculated using the following formula: 2.757 + (.0015 * count) + (-.08957 * age in years) + (-.000038 * count * age in years). The number of minutes spent in each category of activity was summed for each day, as well as divided by the total number of minutes the student wore the monitor to give a percentage of time spent engaging in each activity level. Invalid days of PAM data were removed.

Prior to implementing use of the accelerometers, or PAMs, reliability and validity checks were conducted. Stability measurements were taken from a sample of 30 students (ages 7-15

years) who wore the monitors for 12 hours each day for 6 days. Intraclass correlation reliability estimates of the PAM data for 6 days of data ranged from .81 - .84. In order to assess the amount of days needed to obtain a valid measure of "usual activity" in children, 381 students wore the PAM for 7 consecutive days (ages 6-18). Four days of monitoring were necessary to achieve an intraclass reliability coefficient of R = .80. Seven days of PAM data collection were completed to account for levels of moderate-to-vigorous (MVPA) activity over the weekend. Students engaged in significantly higher levels of MVPA on the weekends as compared to the weekdays.

Problem Behaviors. The CBCL (Achenbach, 1991) measures problem behavior in children. The CBCL was completed by after school providers, mother, and father, partner, or other adult in third and fifth grade. Student behaviors are rated on a 3-point scale, with a score of 0 indicating "not true of the child," and a 2 indicating "very true of the child." Broad internalizing and externalizing scales are provided, as well as narrow-band scales of attention problems, depression, social problems, and aggression. Standardized scores (M=50, SD = 10) are available to determine if a child's behavior falls in the normal range, may be at risk for problems, or is clinically significant and warrants further attention.

Extensive reliability and validity evidence supports the use of the CBCL. Test-retest reliability estimates (intraclass correlations) for the CBCL school-age scale scores (Parent Rating and Teacher Rating forms) ranged from .90 - .95 for the empirically based Total Problems, Total Competence, and Total Adaptive Functioning behavior scales. Internal consistency estimates for the empirically based problem behavior scales ranged from .78 - .97 for the school-age form (Achenbach & Rescorla, Manual for the ASEBA School-Age Forms & Profiles). Criterion validity of the CBCL scores and scales, respectively, is supported by findings that all items differentiated significantly between demographically matched referred and non-referred children

(Achenbach & Rescorla, Manual for the ASEBA School-Age Forms & Profiles). Nakamura, Ebesutani, Bernstein, and Chorpita (2009) assessed the convergent validity of the DSM-Oriented Problems Scales and found them to be statistically significant and positively related with multiple related scales (e.g., Affect and Arousal Scale for Children [AFARS]; Revised Children's Anxiety and Depression Scales [RCADS]; Revised Children's Manifest Anxiety Scales [RCMAS]).

Academic Achievement. The Woodcock-Johnson – Revised Edition (WJ-R; Woodcock & Johnson; 1989) was administered to assess both cognitive functioning and academic achievement. For the purposes of the present study, scores from the Woodcock- Johnson Tests of Achievement (WJ-R-ACH) were used. In third and fifth grade, four WJ-R-ACH subtests were administered: Letter-Word Identification, Passage Comprehension, Calculation, and Applied Problems, yielding a Broad Reading and a Broad Mathematics score. Internal consistency reliability estimates (split-half method) for the WJ-R-ACH range from .94-.98 for the Skills Cluster, and .80-.87 for each individual test. With regard to validity, the Skills Cluster of the WJ-R-ACH had a high correlation in the high .60s with the Boehm Test of Basic Concepts and the Bracken Basic Concepts Scale (McGrew, Werder, & Woodcock, 1991). Raw scores were converted to W scores, a transformation of the Rasch ability scale, where scores are reported on an equal interval scale.

Procedures

Data used in the proposed study were obtained from the SECCYD database, specifically the data collected during Phase III (SECCYD, 2010)[4]. Physical activity data were collected following the home or lab visit over 7 consecutive days during a typical school week when the

[4] For more detailed information on Phase III data collection visit http://www.nichd.nih.gov

students were in the third and fifth grade. Data collection occurred between January and July in third grade, and September and January in fifth grade. Activity Monitors from the Ambulatory Monitoring Applications Division of Computer Science and Applications (CSAs) were given to the family during a home visit along with the instructions sheet and record form. Using a pre-determined script, the research assistant (RA) trained parents and students on how to use the CSA for approximately 10 minutes each at the end of the visit. Following data collection (1 week later), RAs picked up the CSA from the family and recorded the weather conditions for the week. Research assistants then downloaded the CSA data to a CSA specific computer.

The CBCL was completed in either the home or the lab by the mother or primary guardian. An RA conducted a brief warm up activity, and parents were handed a packet of 13 questionnaires; the CBCL was the first checklist to be completed in the packet. Parents completed the CBCL while the student completed assessments (e.g., WJ-R). If more than one parent was present, they were instructed to complete their checklists independently. The CBCL forms were visually scanned to make sure no answers were omitted, placed in an envelope, and scored on the computer in the lab. A trained RA administered the Woodcock-Johnson Psycho-educational Battery – Revised (Woodcock & Johnson, 1989) standardized assessment in the lab in the third and fifth grade (in either the home or lab setting).

Research Design & Data Analyses

The current study utilized a non-experimental design wherein data were collected at multiple time points (third and fifth grade). A combination of bivariate correlations and mediated path analysis approaches were used for the proposed research question. SPSS version 22.0 was used to examine the data and evaluate bivariate correlations, and AMOS was used to analyze the data normality and path models. As presented in Figure 1, the predictor variable was

physical activity, with third grade academic achievement as a covariate, and fifth academic achievement as the outcome variable. The model was tested separately for both Broad Reading and Broad Mathematics. Student problem behavior is a proposed mediator in this relationship.

CHAPTER 3

RESULTS

Descriptive Analyses & Testing of Assumptions

The original dataset included 1010 cases; however, 387 cases were missing at least one variable. Based on a missing value analysis (Appendix A), data were missing not at random (MNAR; Tabachnick & Fidell, 2007). There was no trend for missing data when comparing males to females. However, one site was missing approximately 25% of participant response for reading, math, internalizing, and externalizing data in third grade, almost double that of other sites. In fifth grade, this site was missing 25% of data from reading and math, and approximately 30% of data for fifth grade internalizing and externalizing problem behavior data. However, missing physical activity data in both grades was comparable across all sites. Across all sites, participants from single-parent homes as well as those families who were on public assistance (i.e., food stamps) were more likely to be missing data, especially data for physical activity in fifth grade. If cases were missing data from one predictor in either grade, they were likely missing data from multiple predictors (e.g., if internalizing problem behavior data were missing, externalizing problem behavior data were also missing).

Out of 10,100 cells, 953 cells (9.4%) were missing. Due to the fact that data were MNAR and failed to meet MAR or MCAR assumptions (Tabachnick & Fidell, 2007), maximum likelihood (ML), multiple imputation (MI), or full estimation maximum likelihood estimates (FIML) were not conducted. Current research is mixed as to whether it is appropriate to use ML or MI approaches when data do not meet MAR or MCAR assumptions. While Shafer and Graham (2002) indicate that in many cases it may be appropriate to use MAR approaches when data are MNAR, Enders (2010) recommended further analyses following imputation methods for

MNAR data, such as multiplying by a constant to assure these estimates are not biased. However, the recommendations for this method are varied, some recommendations for the value of the constant are arbitrary, and these approaches were developed over 20 years ago. Due to the fact that ML and MI methods are emerging and appropriateness of missing data methods is mixed in the literature (Enders, 2010), both listwise deletion and MI analyses were run initially. Negligible differences were observed between the results of these two approaches; thus, the following results are based on the cases with complete data (N = 623).

There were no extreme univariate skew or kurtosis values (skew or kurtosis >10; Hu & Bentler, 1999; Kline, 2011). However, multivariate nonnormal data were observed by a critical ratio (CR) value > 5 (Reading CR = 10.42; Math CR = 9.93). Eight multivariate outliers were detected in AMOS as based on Mahalanobis distance values > 25 (Field, 2009). Multivariate normality was achieved after removal of these eight outliers (Reading CR = 3.55; Math CR = 3.03) resulting in a final sample of 615 cases. Final means, standard deviations, skew, and kurtosis are presented in Table 1. Correlations between the variables of physical activity monitoring data (Physical Activity), externalizing problem behaviors (Externalizing), internalizing problem behaviors (Internalizing), reading achievement (Reading), and math achievement (Math) for Grades 3 and 5 are provided in Table 2.

Table 1

Means, Standard Deviations, Range, Skew, and Kurtosis Values for Physical Activity, Internalizing and Externalizing Problem Behaviors, and Academic Achievement in Third and Fifth Grade

	M	*SD*	Range	Skew	Kurtosis
Grade 3					
Physical Activity	181.27	48.43	49.14 - 374.80	.34	.50
Externalizing	47.39	9.97	30 - 74	.33	-.43
Internalizing	48.55	9.85	33 - 77	.37	-.48
Reading	494.69	14.01	440 - 528	-.78	.88
Math	493.66	10.97	454 - 521	-.89	.66
Grade 5					
Physical Activity	121.85	38.56	26.29 – 276.71	.55	.31
Externalizing	46.12	10.13	30 - 77	.39	-.37
Internalizing	48.94	9.69	33 - 84	.32	-.17
Reading	508.10	12.54	459 - 544	-.51	.63
Math	510.97	10.75	476 - 548	-.24	.53

Note. $N = 615$.

In addition, assumptions were tested for the path model analyses. These assumptions included: (a) correct specification of the model's functional form, (b) no omitted variables from the model, (c) no measurement error, (d) homoscedasticity of residuals, (e) uncorrelated error terms across equations, and (f) normally distributed residuals, (g) correct causal ordering of the variables, (h) no reverse causality effects, and (i) no independent variable – mediator interaction (Cohen, Cohen, West, & Aiken, 2003; Fairchild & McQuillin, 2010). This model was correctly

specified; all relevant variables were included in the model. Residuals were normally distributed and homoscedastic as evidenced by visual analyses of P-P and Q-Q plots. The variables were entered in the model based on temporal precedence and the hypothesized relationships amongst the variables. Third grade reading achievement was entered into the model as a covariate. Indirect mediation pathways were introduced to examine complete and partial mediation effects. A priori alpha level was set at .05 for each predictor and effect size at .10 (R^2) to balance Type I and Type II errors. Practical significance associated with each of the predictor variables was based on Cohen's (1988) defined effect sizes of squared partial correlations (pr^2): small = .02, medium = .13, and = .26, as cited in Fairchild and McQuillin (2010). Indices and criteria used to assess model fit were as follows: p = nonsignificant; RMSEA < .08; CFI > .95 (Hu & Bentler, 1999); CMIN/df < 3.00 (Byrne, 2001).

Bivariate correlations and path model analyses were used to answer research questions and examine hypotheses. The results are organized into four sections – bivariate correlations, reading achievement path models, math achievement path models, and exploratory analyses.

Bivariate Correlations

To examine the relationships between student physical activity, internalizing problem behavior, and externalizing problem behavior, Pearson product-moment correlation coefficients were analyzed (Table 2). In third grade, physical activity was positively related to externalizing behavior; however, the magnitude of the relationship was small. In fifth grade, physical activity was not related to externalizing problem behavior. Physical activity and internalizing problem behavior were not significantly related in third grade; however, in the fifth grade physical activity was negatively related to internalizing behavior.

There was a statistically significant negative relationship between student externalizing problem behavior and both reading and math achievement in third grade and in fifth grade. However, the relationship between internalizing problem behavior and both reading and math achievement was not significant in third or fifth grade. There also were significant negative relationships between student physical activity, reading, and math achievement in fifth grade. While statistically significant, the magnitude of these relationships was small. Furthermore, this was not the hypothesized directionality of these relationships. Overall, while there are some statistically significant relationships between variables in the present study, the magnitude of all of these relationships is small.

Table 2

Correlations Between Student Physical Activity, Internalizing and Externalizing Problem Behaviors, Reading Achievement, and Math Achievement

Variable	1	2	3	4	5	6	7	8	9	10
Third Grade										
1. Physical Activity	-									
2. Externalizing	.12**	-								
3. Internalizing	-.01	.57**	-							
4. Reading	-.07	-.19**	-.06	-						
5. Math	-.09*	-.16**	-.07	-.62**	-					
Fifth Grade										
6. Physical Activity	.54**	.03	-.06	-.11**	-.12**	-				
7. Externalizing	.09*	.77**	.49**	-.17**	-.12**	.00	-			
8. Internalizing	-.01	.47**	.69**	-.04	-.05	-.10*	.60**	-		
9. Reading	-.13**	-.17**	-.06	.87**	.56**	-.17**	-.17**	-.03	-	
10. Math	-.09*	-.20**	-.08*	.58**	.72**	-.12**	-.15**	.08	.61**	-

Note. **p < .01; *p < .05.
N = 615

Reading Achievement Model

To examine relationships amongst physical activity, internalizing and externalizing problem behaviors, and reading achievement over time, path analyses were conducted using AMOS. Due to the fact that reading achievement scores in third grade were collected at approximately the same time as physical activity data, third grade reading achievement was included as a covariate rather than a mediation variable. Furthermore, previous research has not accounted for prior achievement when addressing the relationships examined in this study (e.g., Coe et al., 2013; Malecki & Elliott, 2002). Figures 2 and 3 provide initial and final path models.

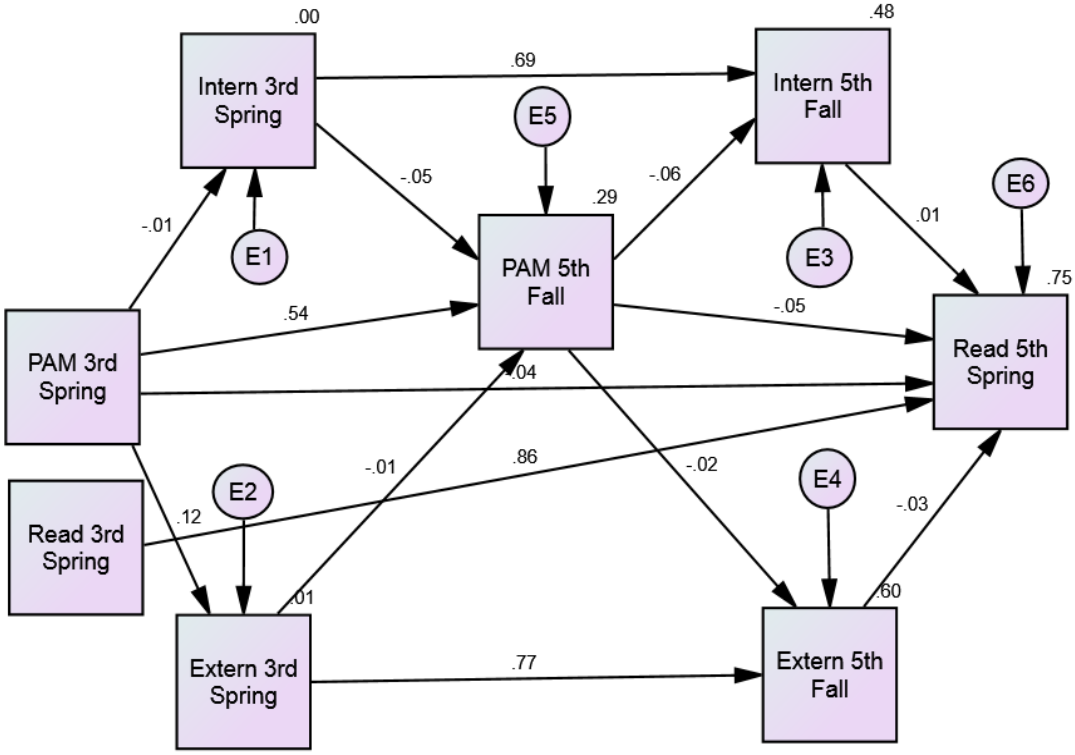

Figure 2. Proposed model of the longitudinal relationships amongst physical activity, student problem behavior, and reading achievement (standardized coefficients).

The proposed model did not demonstrate good fit with the data (Table 3). Based on review of modification indices, three changes were made to improve model fit: (i) error terms for internalizing and externalizing problem behaviors in the third grade were correlated, (ii) error terms for internalizing and externalizing problem behaviors in the fifth grade were correlated, (iii) the path between reading in third grade and physical activity in fifth grade was freed. The final revised model (Figure 3) demonstrated acceptable fit with the data. Initial and subsequent fit indices are provided in Table 3.

Table 3

Fit Indices for the Proposed Reading Path Model and Modifications

Model	χ^2	*p*	*DF*	CMIN/*df*	RMSEA	CFI
Proposed model	444.34	.00	14	31.74	.22	.83
Add e1 – e2	199.09	.00	13	15.32	.15	.93
Add e3 – e4	54.75	.00	12	4.56	.08	.98
Add Reading 3rd – Physical Activity 5th (final model)	49.56	.00	11	4.51	.08	.98

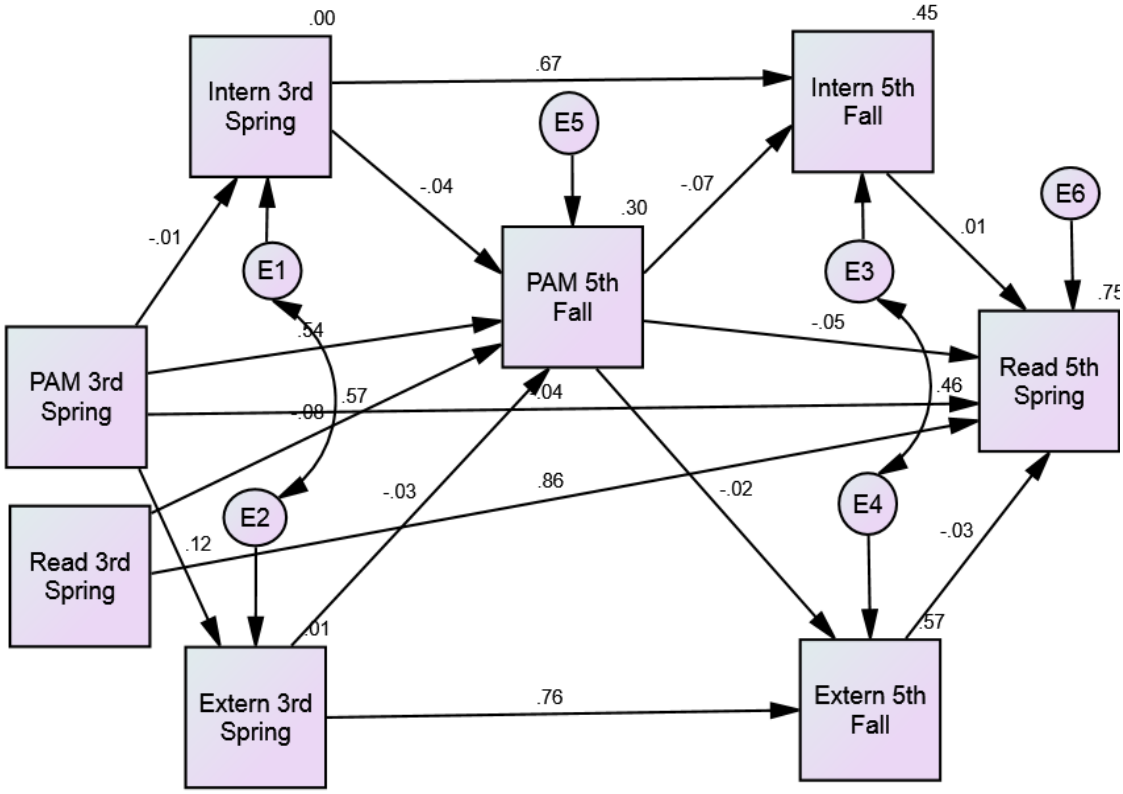

Figure 3. Final model of the longitudinal relationships amongst physical activity, student problem behavior, and reading achievement (standardized coefficients).

Standardized direct, indirect, and total effects within the model were evaluated to examine the hypothesized mediated relationship between physical activity and reading achievement. Multiple criteria were used to judge if student problem behaviors significantly mediated the relationship between physical activity and academic achievement. As recommended by Preacher and Hayes (2008) and Kline (2011), maximum likelihood bootstrapping techniques were utilized to obtain measures of indirect bias-corrected confidence intervals (CI) and standard errors; 5,000 samples were requested with a 95% CI. Bootstrapping was used in lieu of Sobel's test, as the raw data were accessible (Preacher & Hayes, 2008). Table 4 provides a complete list of standardized direct, indirect, and total effects with respective confidence intervals.

The standardized direct effect of physical activity in third grade on fifth grade reading achievement was not statistically significant; however, physical activity in fifth grade was significantly related to reading in fifth grade. While statistically significant, this relationship was opposite than hypothesized. Every 1 standard deviation increase in physical activity predicted approximately a .05 standard deviation decrease in reading achievement. The standardized direct effect of externalizing or internalizing problem behaviors in fifth grade on subsequent reading achievement was not significant.

The standardized indirect effect of third grade physical activity on fifth grade reading achievement was statistically significant. Internalizing and externalizing problem behaviors were hypothesized to mediate the relationship between physical activity and reading achievement. Indirect effects were not significant in third or fifth grade. The indirect effect of problem behaviors did not mediate the relationship between physical activity and academic achievement, as further evidenced by confidence intervals containing zero.

The standardized total effect of third grade physical activity on fifth grade reading achievement was statistically significant. The total effect of fifth grade physical activity on fifth grade reading achievement was also statistically significant and equivalent to the direct effect. Again, while statistically significant, these relationships were of small magnitude and in the opposite direction than was hypothesized. Analysis of this model did not provide support for predictions with regards to reading achievement.

Table 4

Standardized Direct, Indirect, and Total Effects on 5th Grade Reading Achievement with 95% Confidence Intervals

	Direct		Indirect		Total	
	β	CI_{95}	β	CI_{95}	β	CI_{95}
Third Grade						
Reading	.86**	[.84 – .88]	.00	[.00 – .01]	.86**	[.85 – .88]
Physical Activity	-.04	[-.08 – .00]	-.03*	[-.05 – -.01]	-.07**	[-.10 – -.03]
Internalizing	--		.01	[-.02 – .04]	.01	[-.02 – .04]
Externalizing	--		-.02	[-.05 – .01]	-.02	[-.05 – .01]
Fifth Grade						
Physical Activity	-.05*	[-.09 – -.01]	.00	[.00 – .00]	-.05*	[-.09 – -.01]
Internalizing	.01	[-.03 – .06]	--	--	.01	[-.03 – .06]
Externalizing	-.03	[-.07 – .02]	--	--	-.03	[-.07 – .02]

Note. **p < .01; *p < .05.

Mathematics Achievement Model

The initial proposed model examining the paths between physical activity, internalizing and externalizing problem behaviors, and math achievement is depicted in Figure 5.

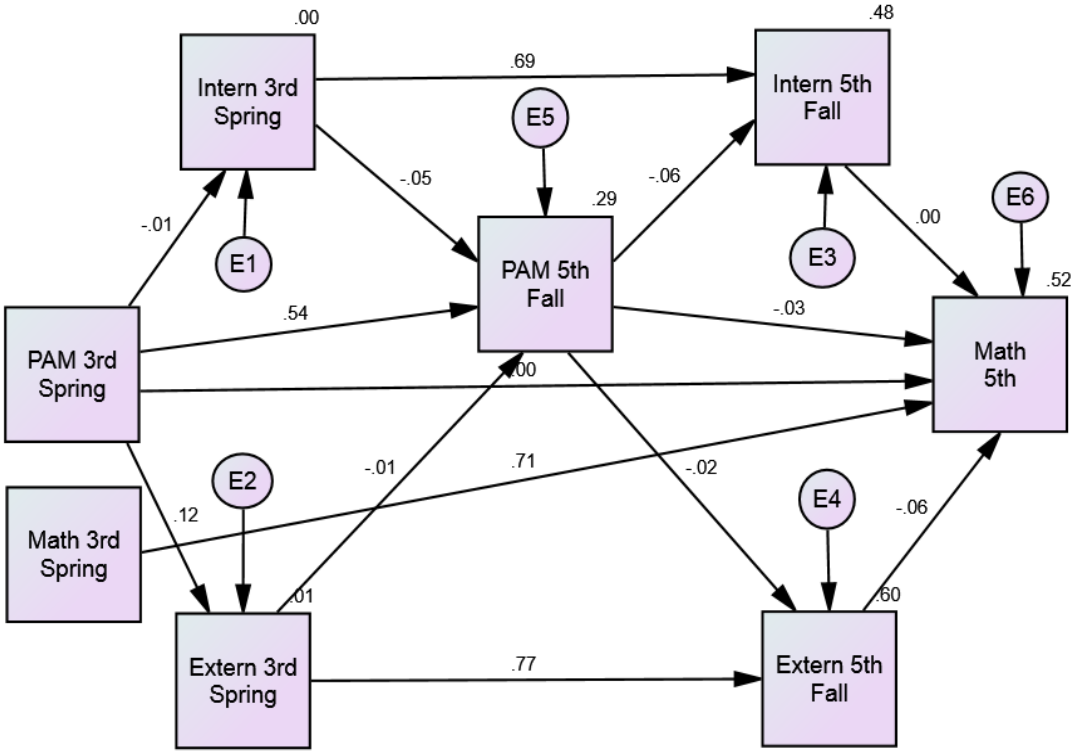

Figure 4. Proposed model of the longitudinal relationships amongst physical activity, student problem behavior, and math achievement (standardized coefficients).

Table 5

Fit Indices for the Proposed Mathematics Path Model and Modifications

Model	χ^2	*p*	*DF*	CMIN/*df*	RMSEA	CFI
Proposed	442.00	.00	14	31.57	.22	.79
Add e1 – e2	196.75	.00	13	15.14	.15	.91
Add e3 – e4	54.41	.00	12	4.37	.07	.98
Add Math 3rd – Physical Activity 5th (final model)	46.85	.00	11	4.30	.07	.98

The proposed model did not demonstrate good fit to the data; three changes were made to improve model fit: (i) error terms for internalizing and externalizing problem behaviors in the third grade were correlated, (ii) error terms for internalizing and externalizing problem behaviors in the fifth grade were correlated, (iii) the path between math in third grade and physical activity in fifth grade was freed. Initial and subsequent fit indices are provided in Table 5. Similar to the reading model, the revised model demonstrated acceptable fit with the data across some of the fit indices.

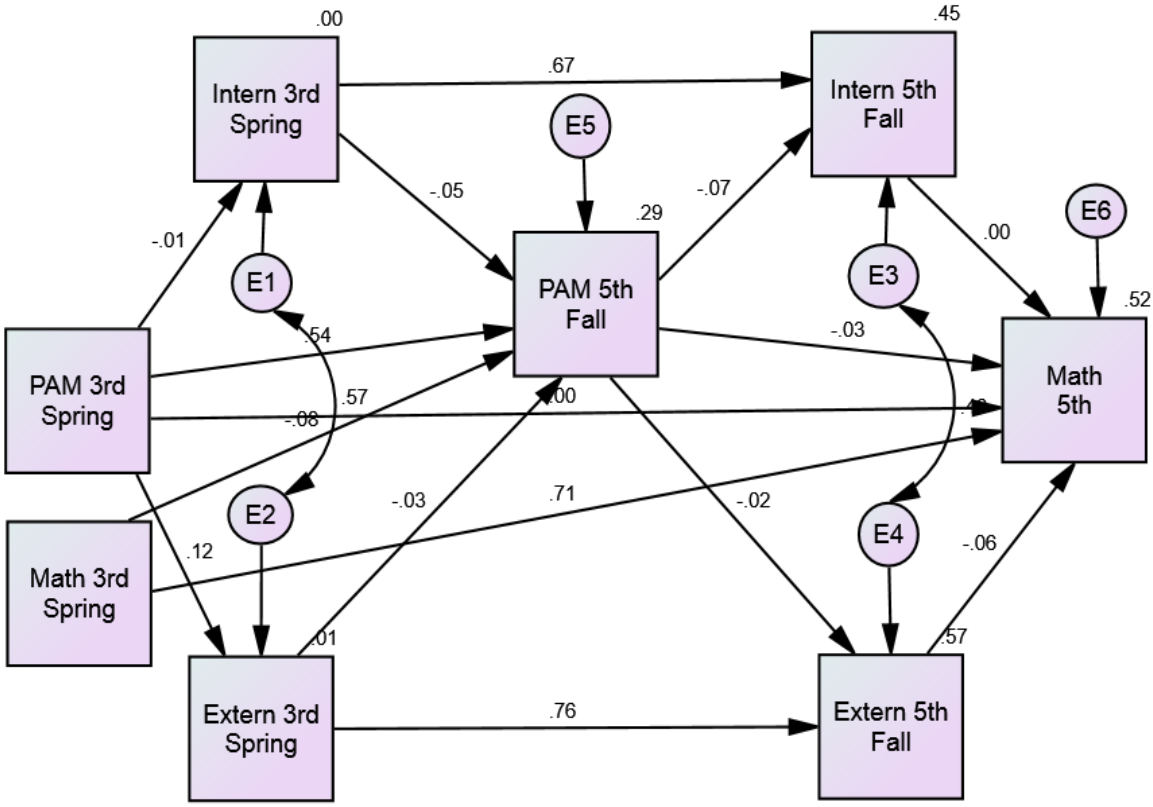

Figure 5. Final model of the longitudinal relationships amongst physical activity, student problem behavior, and math achievement (standardized coefficients).

As shown in the above models evaluating the relationships amongst student physical activity, internalizing and externalizing problem behavior, and math achievement, minimal relationships exist amongst the predictors. Table 6 provides a complete list of standardized direct, indirect, and total effects with respective confidence intervals.

Table 6

Standardized Direct, Indirect, and Total Effects on 5th Grade Math Achievement with 95% Confidence Intervals

	Direct		Indirect		Total	
Standardized Effects	β	CI_{95}	β	CI_{95}	β	CI_{95}
Third Grade						
Math	.71**	[.67 – .75]	.00	[.00 – .01]	.72**	[.68 – .75]
Physical Activity	.00	[-.06 – .06]	-.02	[-.05 – .01]	-.02	[-.07 – -.03]
Internalizing	--	--	.00	[-.04 – .03]	.00	[-.04 – .03]
Externalizing	--	--	-.05	[-.09 – .00]	-.05	[-.09 – .00]
Fifth Grade						
Physical Activity	-.03	[-.09 – .03]	.00	[.00 – .01]	-.03	[-.09 – .03]
Internalizing	.00	[-.06 – .05]	--	--	.00	[-.06 – .05]
Externalizing	-.06	[-.12 – .00]	--	--	-.06	[-.12 – .00]

Note. **p < .01; *p < .05.

Exploratory Post-Hoc Analyses

Removal of third grade achievement covariate. Given a number of previous studies (e.g., Chomitz et al., 2009; Coe et al., 2013; Donnelly et al., 2009) examining the relationship between physical activity and academic achievement without including prior achievement as a covariate, exploratory analyses were run while omitting third grade achievement from the proposed model. Exploratory analyses were run without third grade achievement in the model to examine the effect that it had on the relationships within both reading and math models (Appendix B). When prior achievement was not included in the model, the direct relationship between externalizing problem behavior and both reading and math achievement were significant. Significant direct relationships, however, were not observed between internalizing problem behavior and achievement. The indirect relationships between physical activity and both reading and math were not significant.

Gender analyses. Several studies have found gender to moderate the relationship between physical activity and a variety of mental health outcomes (Ahn & Fedewa, 2011). As such, path models were analyzed separately for boys and girls to explore the possibility of differential relationships by gender. Results of these analyses (Appendix C) indicated few differences in model relationships across boys and girls. One difference, however, was observed in the direction of the relationship between physical activity and internalizing behavior in third grade. While boys' physical activity was negatively related to internalizing behavior in third grade, girls' physical activity was positively related to internalizing behavior in third grade. Similarly, boys' externalizing behavior in third grade was negatively related to fifth grade physical activity, whereas girls' externalizing behavior was positively related to physical activity in fifth grade. These differences were observed in both reading and math models.

CHAPTER 4

DISCUSSION

The purpose of the present study was to examine the hypothesized mediation effects of student problem behavior on the relationship between physical activity and subsequent academic achievement. Previous research has examined many of these relationships separately (e.g., physical activity and problem behavior [Kirkcaldy, Shephard, & Siefen, 2002]; problem behavior and academic achievement [Hinshaw, 1992; Nelson et al., 2004]; and physical activity and academic achievement [Centers for Disease Control and Prevention, 2010]). However, few previous studies examined all three of these variables over time while accounting for prior achievement. Data from the SECCYD database were analyzed to test hypothesized relationships among these variables. Results indicated few significant relationships and raise several questions about findings from previous studies as well as provide directions for future research.

Interpretation of Results

The overarching hypothesis, which posited that student problem behaviors mediate the relationship between physical activity and academic achievement, was not supported. As demonstrated in the path models (Figures 2-6), few relationships achieved both statistical and practical significance amongst student physical activity, internalizing and externalizing problem behavior, and reading and math achievement. The majority of direct or indirect effects that were both statistically and practically significant were those between the same variable across grades (e.g., externalizing behavior in third and fifth grade).

The relationship between physical activity and internalizing problem behavior was not significant. This lack of relationship was counter to expectations based on previous literature

demonstrating significant relationships between physical activity, depression, anxiety, and self-concept (e.g., Ahn & Fedewa, 2011). In the present study, third grade physical activity was positively related to externalizing problem behavior, which was the opposite direction of the hypothesized relationship. This relationship was not significant in the fifth grade. Research evaluating the relationship between physical activity levels and externalizing problem behaviors (rule-breaking, aggression) is sparse. Ahn and Fedewa (2011) examined the relationship between physical activity and conduct problems, and they found no significant relationships across either experimental or correlational studies.

The relationship between physical activity and academic achievement was minimal. Much of the current research surrounding the effects of physical activity on academic achievement has found either positive relationships or no relationship (Active Living Research Brief, 2009, Rasberry et al., 2011). Donnelly and Lamborne (2011) reported significant positive effects of a classroom-based physical activity intervention (Physical Activity Across the Curriculum) on academic achievement when comparing experimental and control conditions. Similar to the present results, Coe et al. (2006) and Tremblay, Inman, and Williams (2000) found no relationship between levels of physical activity and academic achievement (standardized tests or grades).

Exploratory analyses. Given the fact that many previous studies (e.g., Coe et al., 2006; Tremblay, Inman, & Williams, 2000; Roberts, Freed, & McCarthy, 2010) did not include prior achievement, prior achievement was removed from the final model to evaluate if this predictor accounted for variance otherwise shared between problem behaviors and achievement (Appendix B). When the academic achievement covariate was removed in the exploratory analyses, the relationships between externalizing problem behaviors and academic achievement, particularly

externalizing behaviors and reading achievement, changed to one that was both statistically and practically significant. Inclusion and subsequent removal of prior achievement highlights the importance of accounting for prior achievement when examining longitudinal relationships. Many previous studies examining these relationships (Ahn & Fedewa, 2011; Breslau et al., 2009; Tremblay, Inman, & Williams, 2000) accounted for age, gender, cognitive ability, and various other influential factors, but prior achievement scores often were not available or included. It is possible that inflated relationships were observed in previous studies due to the omission of prior achievement data.

Additionally, exploratory analyses were conducted to explore if relationships differ by gender. Some differences in directionality were observed between boys' and girls' physical activity in third grade and internalizing behavior in third grade, as well as between externalizing behavior in third grade and fifth grade physical activity. When evaluating these relationships by gender, the overall magnitude of the relationships was similar to the models that were tested with the whole sample. Furthermore, the direct, indirect, and total effects in the separate models for boys and girls were still small.

Plausible Explanations for Current Results

Physical activity intervention. While the present findings were counter to what was hypothesized, they are not completely inconsistent with previous literature. Both experimental and non-experimental studies focusing on bivariate relationships have found either positive correlations or no relationship between physical activity and academic achievement. While the research base is mixed, studies focused on interventions promoting physical activity, as opposed to correlational studies, tend to demonstrate statistically significant relationships between

physical activity and internalizing problem behavior (e.g., Barr-Anderson, 2011; Donnelly & Lambourne, 2011; Donnelly et al., 2009; Kibbe et al., 2011; Mahar et al., 2006).

For example, Donnelly et al.'s (2009) study implemented an intervention in the classroom (PAAC). Schools within a district were randomly assigned to receive a physical activity intervention for three years, which included an additional 90 minutes of moderate-to-vigorous physical activity per week as part of academic instruction. Student achievement as measured by standardized assessments showed significant improvement as compared to students' achievement in schools that did not receive this intervention. It is likely that they found significant and meaningful positive effects of this intervention on academic achievement due to the implementation of a physical activity intervention wherein additional physical activity was introduced. Furthermore, the physical activity that was introduced was rated as moderate-to-vigorous.

Results of the meta-analysis conducted by Ahn and Fedewa (2011) indicated that, in both randomized controlled trails (RCT) and non-randomized controlled trials (non-RCT), physical activity interventions resulted in decreased levels of depression, anxiety, psychological distress, and emotional disturbance in children. Furthermore, they found that increasing levels of physical activity led to increased levels of self-esteem. In contrast, correlational studies only demonstrated significant relationships between physical activity, depression, and enhanced self-concept. Similarly, Tremblay, Inman, and Willms (2000) did not find a significant relationship between physical activity and academic achievement. However, they did not implement an intervention, these data were only available for sixth grade, and physical activity was evaluated via a four question self-report.

The CDC's (2010) meta-analysis addressed the effect of four different types of school-based physical activity (physical education, recess, classroom physical activity, and extracurricular physical activity) and their effect on a variety of student outcomes (e.g., academic achievement, academic behavior, and cognitive skills and attitudes). Within the meta-analysis, neither intervention nor non-intervention studies were more likely to result in positive associations. While this meta-analysis did not uncover significant differences between intervention studies and observational studies, reviews and meta-analyses specifically evaluating physical activity interventions (e.g., Barr-Anderson et al., 2011; Donnelly & Lambourne; 2011; Kibbe et al., 2011) uncovered more significant positive associations with academic achievement, academic behaviors, and cognitive function. It appears as if recent studies that implement physical activity interventions with fidelity may be more likely to yield significant outcomes on academic behaviors, achievement, and cognitive functioning when evaluating the complexities of these relationships.

Overall effects of physical activity. Prior research tends to focus on the short-term, or immediate, benefits of exercise interventions at school on performance or on-task behavior in the school setting (Donnelly & Lambourne, 2011; Goffreda, & DiPerna, 2010; Mahar et al., 2006; Whitt-Glover, Ham, & Yancey, 2011). The current study, however, focused on the long-term effect of overall levels of students' physical activity on both problem behaviors and academic achievement.

Results indicated that there were no long-term direct or indirect relationships between overall physical activity and academic achievement. It is possible that any benefits from exercise have a more immediate impact, and analysis of overall levels of physical activity diminished the strength of any potential relationship. Many prior studies that found a

relationship between physical activity and various outcomes were measuring the effect of physical activity interventions, recess, or P.E. (e.g., ALR Brief, 2013; CDC, 2010; Goffreda & DiPerna, 2010; Mahar, 2006) on relatively immediate outcomes such as attention, on-task behavior, and self-esteem. However, the duration of these effects is unknown.

Measurement. The use of accelerometer data over the course of one week is a relatively novel method of measurement when addressing the effects of physical activity in the school setting. While use of accelerometer data is advantageous in that it measures the amount of Moderate-to-Vigorous physical activity in which students engage, the majority of studies evaluating these relationships use physical activity interventions, amount of time spent in P.E. or extracurricular activities, and/or amount of time spent at recess (CDC, 2010). Use of measurement tools that more closely align with the school setting, rather than an overarching measurement of minutes of physical activity, might be more consistently related to academic outcomes. For example, wearing the accelerometers only during school hours might more accurately reflect how students' levels of physical activity might affect their problem behaviors and academics.

Along those same lines, the CBCL measured both internalizing and externalizing problem behaviors; however, the parent, not the classroom teacher, completed the ratings used for the present study. Stronger relationships amongst physical activity, problem behaviors, and subsequent achievement may have been present if the classroom teacher rated students' behavior as it appears in the academic setting. As noted in Breslau et al.'s (2009) study, parent's rating on the CBCL had "slightly weaker" associations with academic achievement outcomes than did teacher ratings (p. 1475).

Aligning measurement methods as closely as possible to the hypotheses in the present study may have resulted in stronger associations amongst variables. Both physical activity data and CBCL data were gathered at a macro level, rather than at solely the classroom level. Data collected across settings introduced a greater amount of variance than if these measures were completed at the classroom level.

Prior Achievement. The present study included students' prior achievement in the path model analyses. When the third grade achievement covariate was included in the model, no significant relationships were uncovered. However, many previous studies did not include prior achievement scores and found significant relationships between problem behaviors and achievement (Breslau et al., 2009; Hinshaw, 1992; Nelson, Benner, Lane, and Smith, 2004). Those that did include covariates observed changes in statistical significance when these covariates were not previously accounted for. For example, when Breslau et al. (2009) included IQ and attention as covariates in their regression analysis, problem behavior was no longer significantly related to academic achievement.

When third grade achievement was removed from the model in the current study, the relationships between internalizing and externalizing problem behaviors were similar to previous studies that did not account for prior achievement. It is possible that significant relationships reported in prior studies were inflated due to the omission of prior achievement. While the relationships between both internalizing and externalizing behavior became both practically and statistically significant, the removal of the covariate still did not result in a significant mediated relationship between physical activity and academic achievement.

Limitations

The aforementioned results should be interpreted and evaluated within the context of several limitations resulting from the methodology and available SECCYD data. First, a significant percentage of cases were removed due to data missing not at random (MNAR). Current recommendations are mixed regarding the best methodology when working with MNAR data (Enders, 2007; Shafer & Graham, 2002). Specifically, there are different perspectives regarding the use of multiple imputation, maximum likelihood estimation, or listwise deletion to produce the least biased results. As noted in the Results section, it was decided that listwise deletion would be conducted; however, listwise deletion is not a perfect solution to this missing data problem. Listwise deletion requires certain assumptions (MCAR data), and if these assumptions are not met, this approach can result in distorted estimates. (Results of multiple imputation analyses were consistent with the listwise deletion analyses, though.) in the cure.

Second, the analyses conducted for this study were secondary and completed after the original data had been collected. As a result, it was not possible to include additional measures that would have been helpful relative to the purpose of the current study. For example, teacher ratings of behavior as witnessed in the classroom rather than in the home setting may have a stronger relationship to students' subsequent academic achievement.

Concomitantly, the measures that were included were not intended for the specific research questions in the present study. It is possible that minimal relationships were uncovered simply because the instruments used in the present study were not selected based on these specific constructs to be measured. Previous research has found that exercise has negative associations with depression and anxiety and positive associations with self-esteem, attention, and on-task behavior (Ahn & Fedewa, 2011). However, the internalizing scale on the CBCL

includes anxious/depressed, withdrawn/depressed, and somatic complaints subscales. While depression and anxiety are subsumed under the internalizing problem behaviors composite, the subscales are not necessarily clearly differentiated. In addition, much of the research exploring the benefits of exercise on anxiety and depression is focused on adult populations (Biddle & Asare, 2011), and more positive associations have been found at the secondary level as compared to elementary students (CDC, 2010). It is possible that these relationships become more pronounced as youth reach adolescence and adulthood.

Finally, much of the previous literature uses the number of minutes and/or intensity of exercise in physical education classes, classroom physical activity interventions, extracurricular activities, or recess at school (CDC, 2010; Rasberry et al., 2011) to determine physical activity levels. Specifically, studies that have found the most significant results are those that focused on a physical activity intervention and the immediate effects following the intervention (e.g., Donnelly & Lambourne, 2011).

In contrast, physical activity levels in the SECCYD database were measured via physical activity accelerometers worn by students in the home and school setting over the course of one week. Accelerometer data collected over the course of one week is a broader measure of physical activity that is not specific to students' activity in the school setting. The current hypotheses were school specific, and this measure of physical activity broadly assessed overall student physical activity. Furthermore, this method of measurement of physical activity did not introduce additional exercise or a different type of exercise in the school environment.

It is possible that this difference in the type of data collection instrument yielded somewhat different findings than previous studies. In the present study, parent and/or student reports of levels of physical activity were not used, as they tend to over- or underestimate

physical activity levels (as cited in Trost et al., 2002). While Trost et al. (2000) posited that seven days of accelerometer data are sufficient for adequate day-to-day reliability, it is possible that this means of data collection was not necessarily representative of students' physical activity both exclusively within the school setting as well as across a longer time span.

Directions for Further Research

The findings and limitations from this study offer several directions for future research. Given the results of the present study, continued efforts should focus on the presence and/or type of intervention implemented, as well as the immediacy of effects of this potential mediated relationship across the intermediate and secondary grades. Additionally, inclusion of prior achievement in future studies would account for students' previous skills. Evaluation of these relationships at one point in time does not account for students' growth or how mitigating factors can come into play when addressing these relationships.

Addressing the immediate impact of a school-based physical activity intervention may result in greater significant associations. Specifically, introducing a physical activity intervention above and beyond the typical amount of physical activity in students' day might yield a more significant result than simply shifting P.E. curriculum or changing the type of activity in which students are already engaging. Additionally, exploring different types of exercise implementation would further the knowledge of the potential differential effects of varying intensities and types of activity. Ahn and Fedewa (2011) found that circuit training, strength training, and combination exercise (aerobic and resistance training) produced the greatest effects on students' behaviors or mental health; academic achievement was not included in these analyses. Additionally, consideration of both school- and classroom-level variables could provide additional insights regarding factors that contribute to variability in levels of

physical activity during the school day. Further research in the field could hone in on what types of physical activities are most effective and produce the most results in different types of classrooms.

Furthermore, research examining externalizing problems as a moderator rather than a mediator could provide additional insight regarding the impact of physical activity in school. Specifically, such research could examine if physical activity has a greater impact on students who are known to have externalizing problems in the school setting. Evaluation of these relationships in a slightly different context with a different set of research questions and methodology could uncover additional student differences with regard to the effects of physical activity.

Lastly, problem behaviors might be replaced with "academic behaviors," such as attention, focus, and/or on-task behavior. Goffreda and DiPerna (2010) found decreases in off-task behaviors and increases in classroom engagement immediately following implementation of Energizers. Rasberry and colleagues (2011) found positive associations between recess and attention, on-task behavior, concentration, and/or classroom behavior. However, the positive effects could have been due to presence of a break, not necessarily a physical activity intervention. A future study could involve implementation of a brief, high intensity physical activity break, a break with no physical activity, and a control group who does not receive a break. Effects of these interventions could be measured by observing on-task classroom behavior or mood following this intervention and subsequent achievement on a brief academic achievement measure such as progress monitoring tools. Inclusion of multiple time points that extend into the upper grades would be beneficial to expand upon the current research base,

especially given the fact that positive associations have been more commonly observed at the secondary level (CDC, 2010).

Conclusion

Increase in the accountability of school districts to have students attain certain academic standards has resulted in electives such as physical education getting cut from schools' budgets (Pate et al., 2006; Sallis, 2010). These changes in school structure have prompted a number of studies on the effects of physical activity on academic achievement. Much of the current literature is focused on the importance of physical activity and its benefits across a multitude of student outcomes. However, many studies have found mixed results on the effects of physical activity on students' academic achievement (CDC, 2010; Coe et al., 2006). Furthermore, many previous studies have not explored potential mediators such as problem behaviors.

The purpose of the present study was to examine these relationships across the intermediate grades and evaluate the mediating effect that students' internalizing and externalizing problem behaviors might have on the relationship between physical activity and academic achievement. Many previous studies have examined these relationships in a variety of contexts, but few studies included physical activity, problem behaviors, and academic achievement across grade levels. Moreover, direct measures of physical activity (in lieu of self- or parent-report) have not been used in many of the prior studies looking at correlational relationships.

The majority of the relationships amongst variables within the current path models were not significant indicating a lack of direct or mediated relationships among physical activity and academic outcomes in reading and mathematics. However, when third grade achievement was removed from the model, the pathways between externalizing problem behavior and reading and

math achievement became both practically and statistically significant. This shift signifies the importance of accounting for prior achievement, and raises questions about findings from previous studies that did not include this covariate when addressing the relationships between problem behaviors and achievement.

Implications of the findings of the present study include the necessity of use of consistent constructs in future research and replication of studies that have found significance. Future researchers should be cautious and thoroughly evaluate the research base before making large shifts in curriculum or community supports. Future research should also address the duration of the effects of exercise, as well as the possible necessity of introduction of physical activity over and above typical levels. Further research on what, if any, interventions produce the greatest outcomes for students would benefit teachers, administrators, school psychologists, educators, and policymakers alike. Awareness of what behaviors physical activity improves upon, if certain academics tend to benefit more from physical activity interventions, and what type and how intense of physical activity intervention to implement would allow educators to benefit from these effects to both their own and their students' full advantage.

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Appendix A.

Table 7

Missing Value Frequencies

Variable	Valid	Missing	% Missing
Third Grade			
1. Physical Activity	792	218	21.6
2. Externalizing	977	33	3.3
3. Internalizing	977	33	3.3
4. Reading	1007	3	0.3
5. Math	1008	2	0.2
Fifth Grade			
6. Physical Activity	744	266	26.3
7. Externalizing	899	111	11.0
8. Internalizing	899	111	11.0
9. Reading	922	88	8.7
10. Math	922	88	8.7

N = 1,010

Appendix B

Exploratory Analyses: Removal of Achievement Covariate

Path Model Without Reading Covariate

To further examine the relationships amongst the variables within the model, adjustments were made to the covariate model to reflect the importance of prior achievement within the model. When third grade reading achievement was taken out of the model, paths within the model that were previously insignificant become significant. This change, or removal of a baseline measure of academics, was conducted to reflect how much of the current literature (e.g., Coe et al., 2013; Mahar et al., 2006; Malecki & Elliott, 2002) does not account for prior achievement when evaluating the strength or existence of these relationships. While fit statistics ($\chi^2 = 24.81$; $p = .00$; $df = 6$; CMIN/$df = 4.14$; RMSEA = .07; CFI = .99) are similar to the covariate model, the amount of statistically significant total, direct, and indirect effects within the path model increase when prior achievement is removed.

When third grade reading achievement was no longer accounted for within the model, the relationships amongst problem behaviors in fifth grade and fifth grade reading achievement became statistically significant. In particular, the strength of the relationship between externalizing problem behaviors and reading achievement increased from $\beta = -.03$ to $\beta = -.20$, whereas the relationship between internalizing problem behavior increased from $\beta = .01$ to $\beta = .08$.

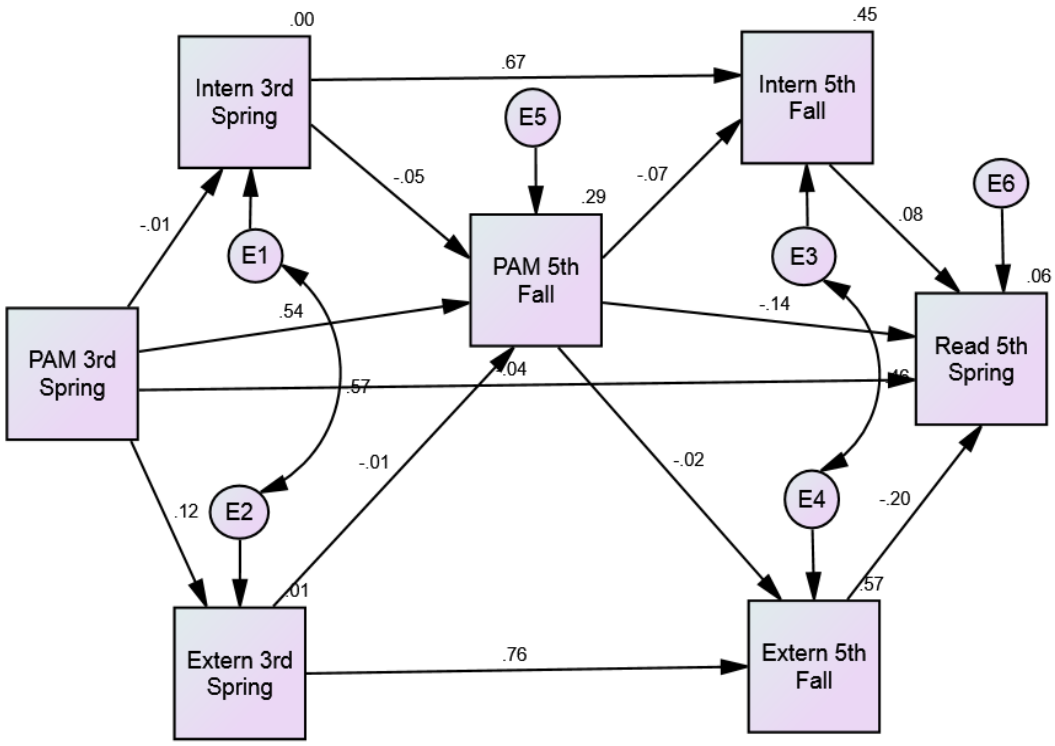

Figure 6. Exploratory model of the longitudinal relationships amongst physical activity, student problem behavior, and reading achievement (standardized coefficients) – covariate removed.

Table 8

Standardized Direct, Indirect, and Total Effects on 5th Grade Reading Achievement with 95% Confidence Intervals – Reading Covariate Removed

	Direct		Indirect		Total	
	β	CI_{95}	β	CI_{95}	β	CI_{95}
Third Grade						
Physical Activity	-.04	[-.12 – .05]	-.09**	[-.14 – -.05]	-.13**	[-.10 – -.03]
Internalizing	--	--	.06	[.01 – .11]	.06	[.01 – .11]
Externalizing	--	--	-.15**	[-.22 – -.09]	-.15**	[-.22 – -.09]
Fifth Grade						
Physical Activity	-.14**	[-.22 – -.06]	.00	[-.01 – .01]	-.14**	[-.22 – -.06]
Internalizing	.08	[.00 – .16]	--	--	.08	[.00 – .16]
Externalizing	-.21**	[-.29 – -.12]	--	--	-.21**	[-.29 – -.12]

Note. **p < .01; *p < .05.

Path Model Without Math Covariate

When third grade math achievement is taken out of the model, the same patterns emerged that were present in the reading model. While fit statistics ($\chi^2 = 33.42$; $p = .00$; $df = 6$; CMIN/df = 5.57; RMSEA = .09; CFI = .98) are similar to the covariate model, the number of statistically significant total, direct, and indirect effects within the path model increase when prior achievement is removed.

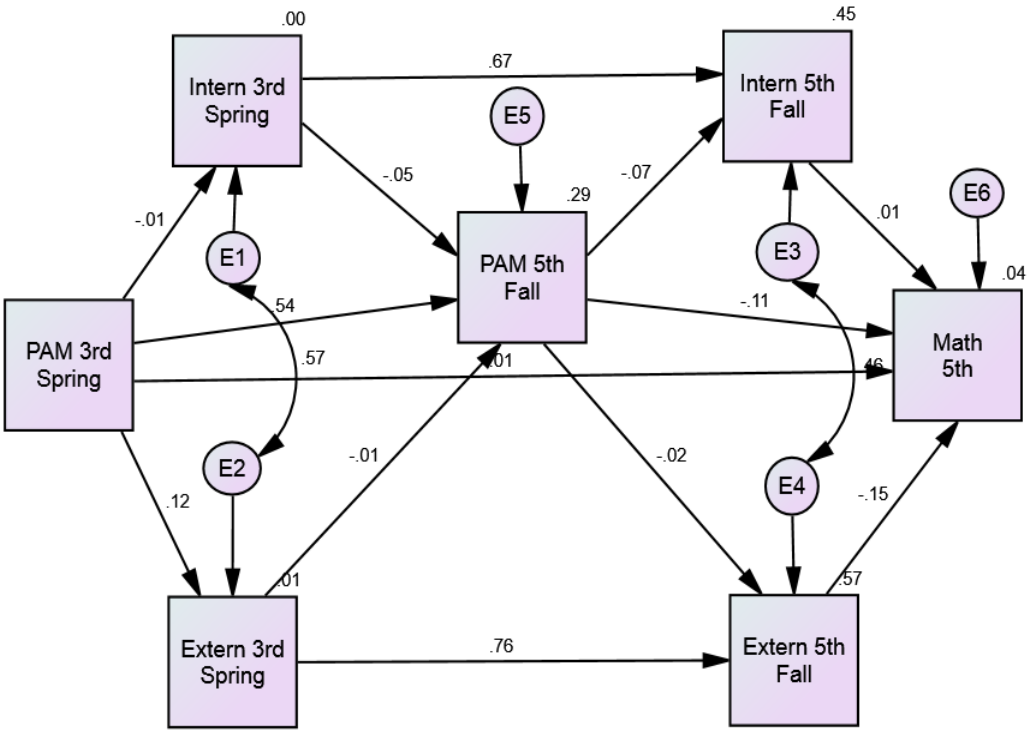

Figure 7. Exploratory model of the longitudinal relationships amongst physical activity, student problem behavior, and math achievement (standardized coefficients) – covariate removed.

Table 9

Standardized Direct, Indirect, and Total Effects on 5th Grade Math Achievement with 95% Confidence Intervals – Math Covariate Removed

	Direct		Indirect		Total	
	β	CI_{95}	β	β	CI_{95}	β
Third Grade						
Physical Activity	-.01	[-.09 – .07]	-.07*	[-.12 – -.03]	-.08*	[-.15 – -.02]
Internalizing	--	--	.01	[-.04 – .06]	.01	[-.04 – .06]
Externalizing	--	--	-.11**	[-.18 – -.05]	-.11**	[-.18 – -.05]
Fifth Grade						
Physical Activity	-.11*	[-.19 – -.03]	.00	[-.01 – .01]	-.11*	[-.19 – -.03]
Internalizing	.01	[-.07 – .09]	--	--	.01	[-.07 – .09]
Externalizing	-.15**	[-.24 – -.07]	--	--	-.15**	[-.24 – -.07]

Note. **p < .01; *p < .05.

Appendix C

Exploratory Analyses: Test of Final Model by Gender

Gender Analyses

To examine the possibility for differential relationships by gender within the model, the final, best fitting path models were analyzed separately for boys and girls. As noted in Table 10, boys and girls had similar internalizing, externalizing, and academic achievement scores; however, boys demonstrated higher mean levels of physical activity.

When evaluating these relationships by gender, the overall magnitude of the relationships was small and similar to the models that were tested with the total sample. However, model fit statistics for boys indicated a better fit relative to the final reading and math covariate models. For boys, reading fit statistics were: $\chi^2 = 15.88$; $p = .15$; $df = 11$; CMIN/$df = 1.44$; RMSEA = .04; CFI = 1.00. Math fit statistics for boys were: $\chi^2 = 9.51$; $p = .58$; $df = 11$; CMIN/$df = .86$; RMSEA = .00; CFI = 1.00. For girls, reading fit statistics were: $\chi^2 = 47.49$; $p = .00$; $df = 11$; CMIN/$df = 4.32$; RMSEA = .10; CFI = .97. Math fit statistics for girls were: $\chi^2 = 53.07$; $p = .00$; $df = 11$; CMIN/$df = 4.82$; RMSEA = .11; CFI = .96. Standardized direct, indirect, and total effects for gender analyses for reading and math are noted in Tables 11 – 14; path models with standardized coefficients are noted depicted in Figures 8 – 11.

Table 10

Means, Standard Deviations, and Significant Difference Values for Physical Activity, Internalizing and Externalizing Problem Behaviors, and Academic Achievement in Third and Fifth Grade – Gender Grouping

	Boys		Girls		
	M	*SD*	*M*	*SD*	*p*
Grade 3					
Physical Activity	190.66	50.13	173.16	45.44	.00**
Externalizing	46.88	9.86	47.82	10.07	.25
Internalizing	48.59	10.22	48.52	9.54	.93
Reading	494.49	14.10	494.87	13.95	.74
Math	493.96	11.25	493.39	10.74	.52
Grade 5					
Physical Activity	131.10	39.73	113.86	35.70	.00**
Externalizing	45.47	9.87	46.68	10.34	.14
Internalizing	49.11	9.87	48.80	9.54	.69
Reading	508.19	12.18	508.03	12.85	.88
Math	511.33	10.79	510.66	10.71	.44

Note. Boys N =285; Girls N = 330.
Note. **p < .01; *p < .05.

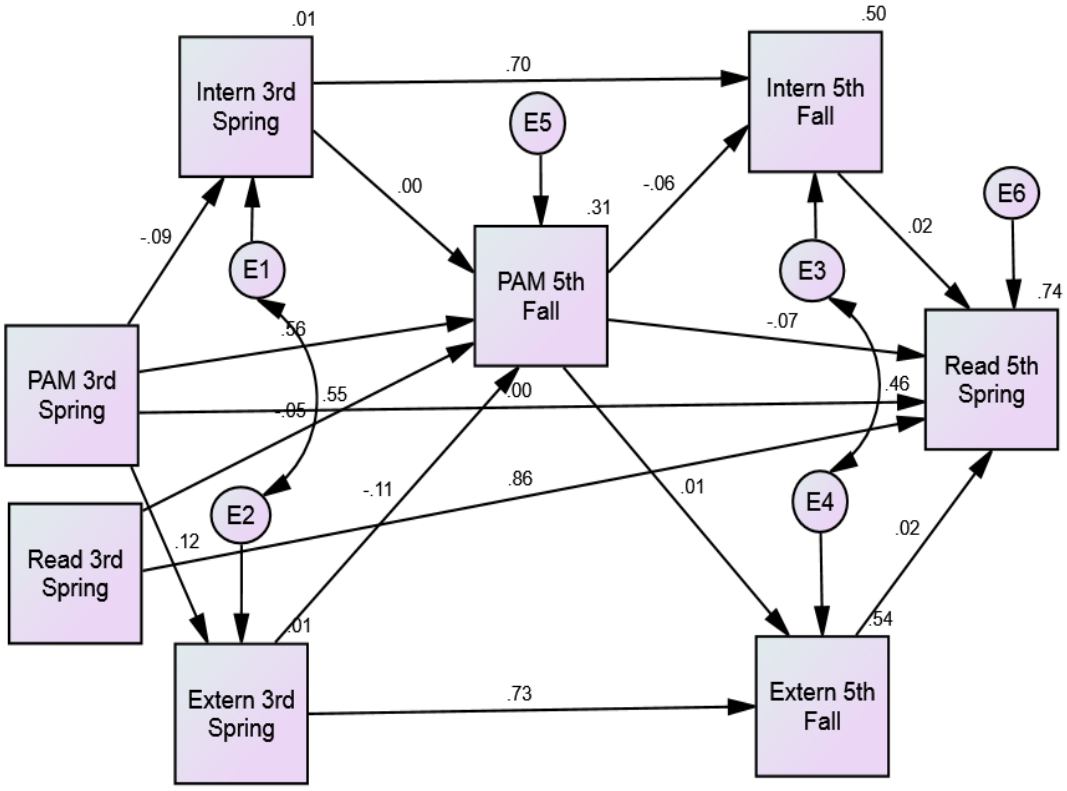

Figure 8. Longitudinal relationships amongst boys' physical activity, problem behavior, and reading achievement (standardized coefficients).

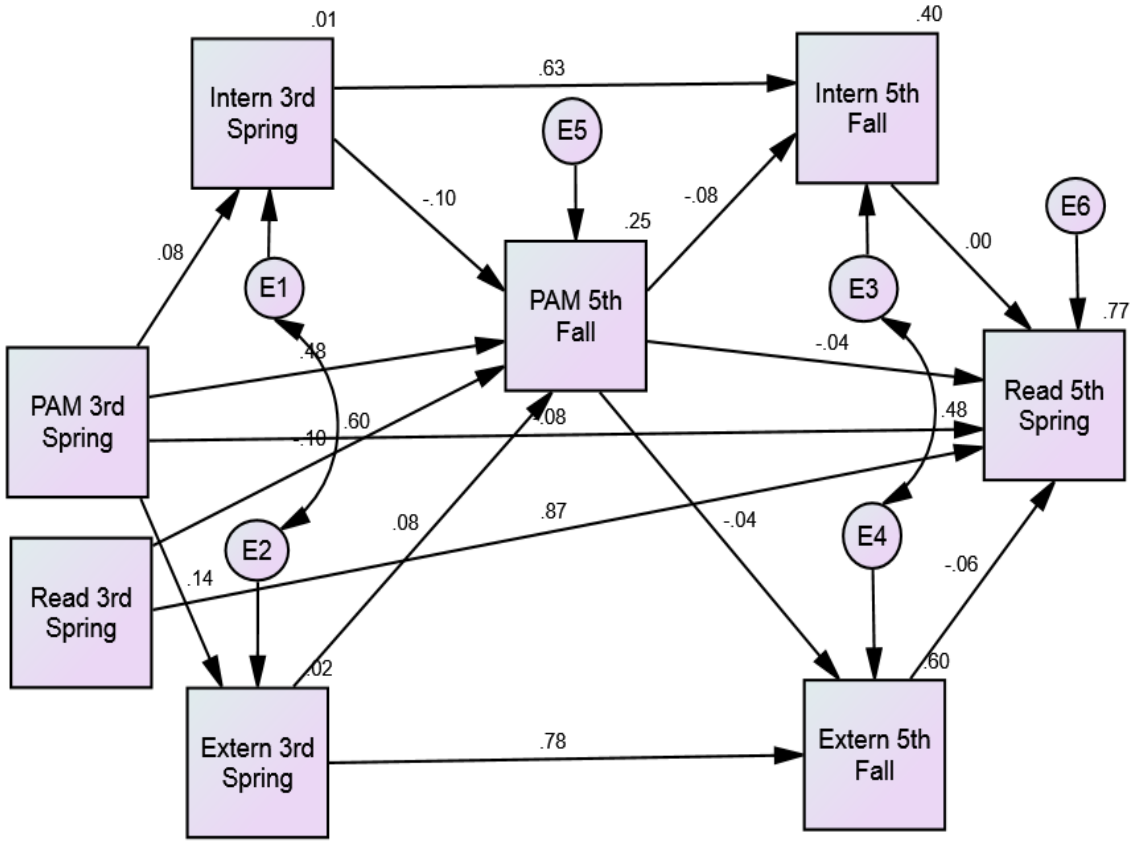

Figure 9. Longitudinal relationships amongst girls' physical activity, problem behavior, and reading achievement (standardized coefficients).

Table 11

Standardized Direct, Indirect, and Total Effects on Boys' 5th Grade Reading Achievement with 95% Confidence Intervals

	Direct		Indirect		Total	
	β	CI_{95}	β	CI_{95}	β	CI_{95}
Third Grade						
Physical Activity	.00	[-.06 – .06]	-.04	[-.08 – -.01]	-.04	[-.10 – .01]
Internalizing	--	--	.02	[-.03 – .06]	.02	[-.03 – .06]
Externalizing	--	--	.02	[-.03 – .07]	.02	[-.03 – .07]
Fifth Grade						
Physical Activity	-.07*	[-.13 – -.02]	.00	[-.01 – .00]	-.07*	[-.13 – -.02]
Internalizing	.02	[-.04 – .09]	--	--	.02	[-.04 – .09]
Externalizing	.02	[-.05 – .08]	--	--	.02	[-.05 – .08]

Note. **p < .01; *p < .05.

Table 12

Standardized Direct, Indirect, and Total Effects on Girls' 5th Grade Reading Achievement with 95% Confidence Intervals

	Direct		Indirect		Total	
	β	CI_{95}	β	CI_{95}	β	CI_{95}
Third Grade						
Physical Activity	-.08**	[-.13 – -.03]	-.02	[-.05 – .00]	-.10**	[-.15 – -.06]
Internalizing	--	--	.01	[-.03 – .04]	.01	[-.03 – .04]
Externalizing	--	--	-.05	[-.09 – .00]	-.05	[-.09 – .00]
Fifth Grade						
Physical Activity	-.04	[-.09 – .01]	.00	[.00 – .01]	-.04	[-.09 – .01]
Internalizing	.00	[-.05 – .06]	--	--	.00	[-.05 – .06]
Externalizing	-.06	[-.11 – .00]	--	--	-.06	[-.11 – .00]

Note. **p < .01; *p < .05.

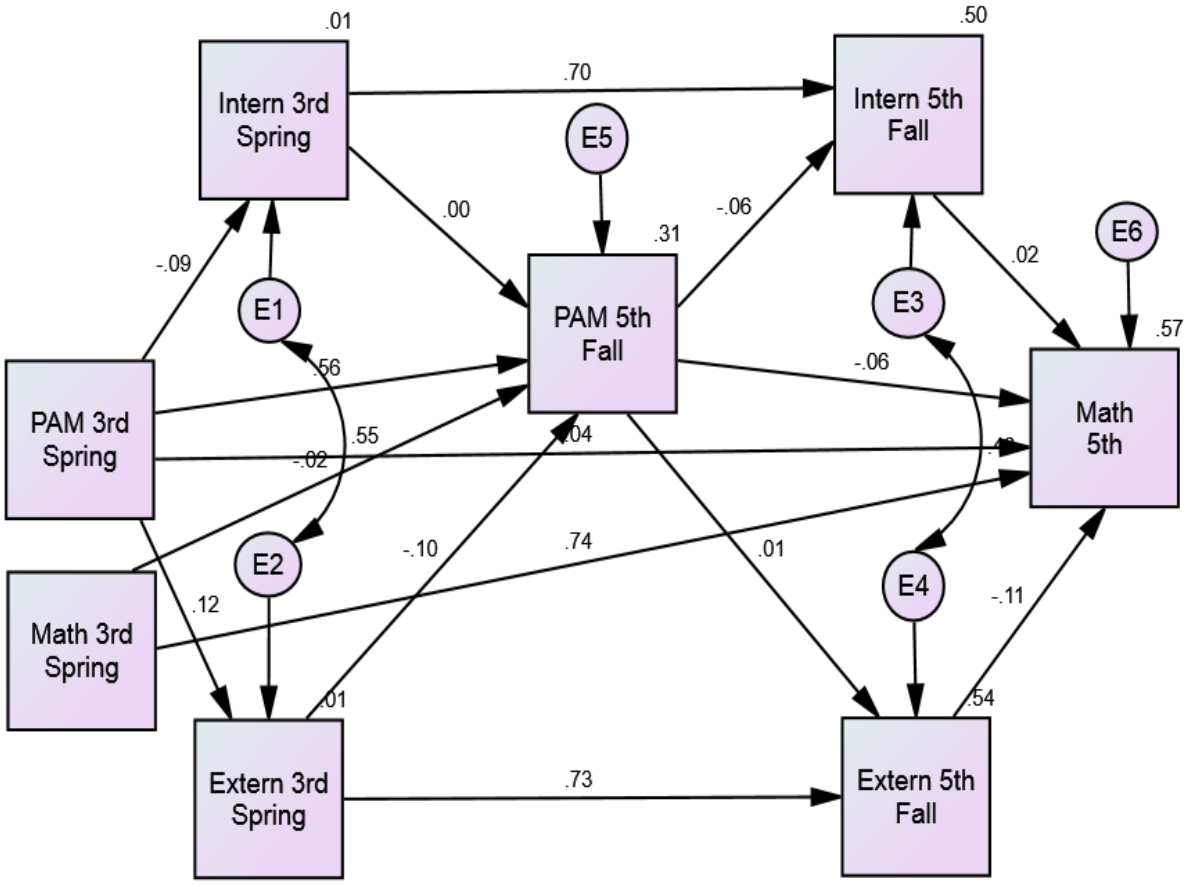

Figure 10. Longitudinal relationships amongst boys' physical activity, problem behavior, and math achievement (standardized coefficients).

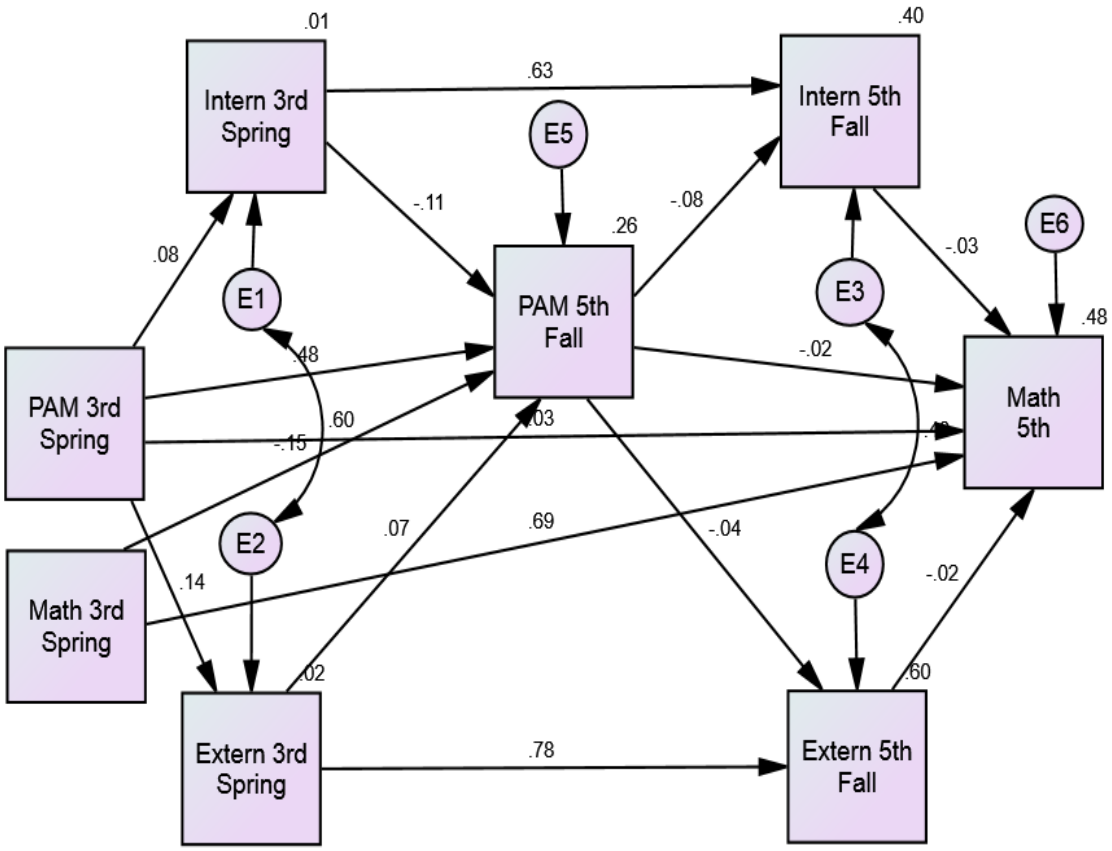

Figure 11. Longitudinal relationships amongst girls' physical activity, problem behavior, and math achievement (standardized coefficients).

Table 13

Standardized Direct, Indirect, and Total Effects on Boys' 5th Grade Math Achievement with 95% Confidence Intervals

	Direct		Indirect		Total	
	β	CI_{95}	β	CI_{95}	β	CI_{95}
Third Grade						
Physical Activity	.04	[-.04 – .12]	-.04	[-.10 – .00]	-.01	[-.07 – .06]
Internalizing	--	--	.01	[-.04 – .07]	.01	[-.04 – .07]
Externalizing	--	--	-.07*	[-.13 – -.02]	-.07*	[-.13 – -.02]
Fifth Grade						
Physical Activity	-.06	[-.14 – .02]	.00	[-.01 – .01]	-.06	[-.15 – .02]
Internalizing	.02	[-.06 – .09]	--	--	.02	[-.06 – .09]
Externalizing	-.11*	[-.19 – -.04]	--	--	-.11*	[-.19 – -.04]

Note. **p < .01; *p < .05.

Table 14

Standardized Direct, Indirect, and Total Effects on Girls' 5th Grade Math Achievement with 95% Confidence Intervals

	Direct		Indirect		Total	
	β	CI_{95}	β	CI_{95}	β	CI_{95}
Third Grade						
Physical Activity	-.04	[-.12 – .04]	-.01	[-.05 – .03]	-.05	[-.12 – .03]
Internalizing	--	--	-.02	[-.07 – .04]	-.02	[-.07 – .04]
Externalizing	--	--	-.01	[-.09 – .06]	-.01	[-.09 – .06]
Fifth Grade						
Physical Activity	-.02	[-.10 – .06]	.00	[.00 – .01]	-.02	[-.10 – .06]
Internalizing	-.03	[-.12 – .05]	--	--	-.03	[-.12 – .05]
Externalizing	-.02	[-.11 – .08]	--	--	-.02	[-.11 – .08]

Note. **p < .01; *p < .05.

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School Psychologist Certification

PENNSYLVANIA DEPARTMENT OF EDUCATION
School Psychologist Certification

GRADUATE RESEARCH AND WORK EXPERIENCE

THE PENNSYLVANIA STATE UNIVERSITY
Graduate Teaching Assistant, Biobehavioral Health
Graduate Research Assistant, Educational Psychology

ARIZONA ASSOCIATION FOR THE EDUCATION OF
YOUNG CHILDREN (AzAEYC)
Administrative Coordinator

PUBLICATIONS

Pavelski, A. I., & Woika, S. A. (2013). Education of the homeless. *The Pennsylvania Administrator.* 17(2), 35-37.