IN-SCHOOL PHYSICAL EDUCATION:
IMPACT ON ACADEMIC PERFORMANCE AND HEALTH STATUS AMONG U.S. ADOLESCENTS

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ABSTRACT

U.S. adolescents suffer from rising obesity rates and inferior academic performance compared to international peers. One potential solution to both problems is to increase opportunities for physical activity via in-school physical education. In addition to improving health status, research shows that physical activity improves academic skill learning, concentration, memory, classroom behavior, and general academic performance. However, little is known about the impact of moderate or high levels of in-school physical education on long-term academic outcomes, including educational attainment and cognitive performance.

This study employed a quasi-experimental design using linear regression analyses to compare no, moderate, and high levels of physical education (P.E.) on academic and health outcomes of U.S. adolescents. Data were analyzed from three waves of the National Longitudinal Study of Adolescent Health. Levels of physical education were distinguished based on: 1) none, which included no days or no minutes of physical activity within P.E.; 2) moderate, which included one to four days per week, or more than zero but less than 30 minutes, of physical activity within P.E.; and 3) high, which included five days per week and more than 30 minutes of daily physical activity within P.E.

Results indicate that students who had moderate to high levels of physical activity within P.E. reported fewer attention problems during class and more years of post-high school educational attainment than students who had no P.E. Additionally, students who had moderate levels of physical activity within P.E. had lower body mass index than students who had no P.E. There was a negative effect of P.E. on academic achievement as measured by grade point average, and there was no effect of P.E. on cognitive performance as measured by a standardized verbal test. The benefits of P.E. for reducing attention problems, increasing years of education, and lowering body mass index warrant further study to examine the extent to which improved attention and health could enhance academic performance. Continued research that connects physical education to academic achievement could validate the need for policies requiring in-school physical activity, which would not only improve health status but potentially improve academic performance of U.S. adolescents.

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Introduction

Adolescent obesity has more than tripled in the past three decades in the United States; one purported reason is decreased opportunities for physical activity in the school (Koplan, Liverman, & Kraak, 2005). Pediatric obesity rates in the U.S. are often cited as reaching epidemic proportions in relation to other developed countries (World Health Organization, 2003). Meanwhile, students in the U.S. continue to lag behind in academic performance compared to their peers in other developed nations (National Center for Education Statistics, 2009). Poor academic performance has prompted a renewed emphasis on core class instruction to the detriment of physical education (P.E.) courses. It is unknown whether or not P.E. has a positive impact on not only students' health status but also academic performance as measured by academic performance, cognitive performance, in-class attention, and educational attainment. A connection between P.E. and students' performance could shift the focus back to the inclusion of P.E. as a supplement to adolescents' activity and a mediator to improve academic performance.

According to *Physical Activity and Health*, a report by the Surgeon General (CDC, 1999), the benefits of physical education are many, including reduced risk of heart disease, strengthened bones, development of muscles, improved aerobic fitness, and increased endurance. Psychological and social benefits include improved self-confidence and self-esteem, an outlet for stress, strengthened peer relationships, reduced risk of depression, and promotion of healthier lifestyles (CDC, 1999). In addition to these physical and social impacts of an active lifestyle, there are also cognitive benefits, including improved academic performance, interest in learning, judgment, and selfdiscipline and goal setting (CDC, 1999). Therefore, research has shown that physical activity has positive impacts on many aspects of a child or adolescent's life.

However, with 16.3% of 2- to 19-year-olds obese and nearly one-third overweight (Ogden, Carroll, & Flegal, 2008), the current recommendation that children and adolescents engage in at least 60 minutes of moderate to vigorous physical activity (MVPA) each day is not being met (USDHHS, 2008). This recommendation, released in October 2008, was an increase from the previous recommendation from the 2005 Dietary Guidelines for Americans for adolescents to engage in 60 minutes of MVPA at least four days each week, yet only 35.8 percent of adolescents met even the former lower recommendation (Eaton et al., 2006). The prevalence of adolescents meeting recommended activity amounts was lower for females than males (27.8% vs. 43.8%, respectively) and for African American than white students (29.5% vs. 38.7%, respectively; Eaton et al., 2006).

A possible reason that adolescents are not meeting physical activity requirements is that many of them do not participate in regular physical education. Few schools require daily physical education (Lee et al., 2007), and only 26 percent of high schools require three years or more of physical education for graduation (USDHHS, 1996). Only 21.3% of U.S. adolescents participate in one or more days of P.E. per week in schools (Gordon-Larsen, McMurray, & Popkin, 2000). Furthermore, P.E. participation is particularly low for non-Hispanic black and Hispanic adolescents, and participation decreases with age for all ethnicities (Gordon-Larsen et al., 2000).

The low participation in P.E. may be largely attributed to an assumed disconnect between P.E. and positive academic outcomes. There is a lack of definitive studies demonstrating a connection between P.E. and academic outcomes, and the burgeoning research in this area remains limited to small-scale experiments rather than studies of large-scale national datasets. However, there are studies that demonstrate a relationship between physical activity and academic outcomes. For example, the relationship between physical activity and cognitive functioning among adolescents has an overall effect size of 0.32 according to one meta-analysis (Sibley & Etnier, 2003). Conversely, the detriments of being overweight on cognitive performance include decreased visuo-spatial organization and general mental ability (Li, Dai, Jackson, & Zhang, 2008).

Controlled experimental studies have shown that physical fitness provides direct cognitive benefits that promote youth's educational attainment. A substantial proportion of physical activity time during the school day (14 to 26% of total class time) has been shown to increase academic skill learning per unit of classroom time (Shephard, 1997). The addition of physical education results in small gains in academic performance, including positive influences on concentration and memory, classroom behavior, and intellectual performance (Strong et al., 2005). Reducing time of P.E. to increase time of other academic subjects has not resulted in improved grades in these subjects; instead the exclusion of this physical activity may be harmful to students' health (Trudeau & Shephard, 2008).

Devoting school curriculum hours to physical activity and P.E. has also not been shown to harm academic performance, even at the expense of shortening other academic courses. Allocating an additional hour per school day to P.E. had no negative effect on the academic performance of students, even when duration of other courses was reduced (Trudeau & Shephard, 2008). A Centers for Disease Control and Prevention (CDC) meta-analysis found that students who participated in P.E. did not suffer harm to their academic performance (Partnership for Prevention, 2000). This meta-analysis examined increased number of minutes of moderate to vigorous activity (MVPA) and increased aerobic fitness across diverse racial, ethnic, and socioeconomic groups, for both genders, all school levels, and in urban and rural areas (Partnership for Prevention, 2000).

Despite research showing a connection between P.E. and academic performance, there is no known large-scale longitudinal study that investigates the impacts of no, moderate, or high physical activity within P.E. on health or academic outcomes. One analysis of the National Longitudinal Study of Adolescent Health, which is examined in the present study, shows that higher in-school physical activity was associated with higher grades (Nelson & Gordon-Larsen, 2006). Even adjusting for socioeconomic status and race, active adolescents had a risk ratio of higher grades of 1.20 for mathematics and 1.21 for English (Nelson & Gordon-Larsen, 2006), two core subjects often measured on standardized tests. Additionally, physical activity duration of more than 20 minutes has been shown to be most effective and efficient in increasing cognitive performance on perceptual and decisional tasks, yet this study by Tomporowski and colleagues (2003) only examined the effects of short-term physical activity on cognitive performance. Longitudinal studies investigating the most effective duration and intensity of physical activity in a curriculum of physical education is lacking, particularly for the high school age group.

Policy Background: Physical Education in U.S. Schools

Despite findings that participation in school P.E. significantly increases the likelihood of adolescents engaging in physical activity (Popkin, Duffey, & Gordon-Larsen, 2005), the health benefits of physical education have not seemed to solidify its place as a high priority in school curriculum. A primary reason for the low participation in P.E. is a lack of funding to support P.E. programs in schools. This lack of resources is based at least in part on a lack of substantive findings that P.E. results in improved grades or test scores (Taras & Potts-Datema, 2005). Despite findings that participation in school physical education programs significantly increases the likelihood of adolescents engaging in physical activity (Popkin, Duffey, & Gordon-Larsen, 2005), a widely held belief in a disconnect between physical activity and academic performance means that funding, resources, and time are dedicated to core subjects, often at the expense of physical education programs (Taras & Potts-Datema, 2005).

The recent federal push toward increased accountability via the No Child Left Behind Act of 2001 has resulted in the reduction of funding for school programs that do not strengthen performance in core academic subjects measured by standardized tests. While there have been federal divisions established for the prevention of childhood obesity, such as the CDC's Division of Nutrition, Physical Activity, and Obesity (DNPAO) and the Division of Adolescent and School Health (DASH), both of these divisions have suffered budgetary cutbacks in recent years and now service fewer than half of the states (Clymer, 2008). Physical education has thus become a low priority in schools, again largely because there has been no definitive connection between P.E. and academic performance as measured by standardized test scores (Story, Kaphinst, & French, 2006).

Despite lack of funding, however, there is a federal push towards regulating school wellness in the form of nutrition and physical activity requirements in schools. Governmental acts lobbied by parents, school administrators, and other stakeholders (such as The Stop Obesity in Schools Act, H.R. 1163, 2008) mandate that the U.S. Department of Health and Human Services (HHS) and other federal agencies develop a collaborative national strategy aimed at reducing childhood obesity within the school setting. The Surgeon General and *Healthy People* 2010, a multi-faceted public health effort spearheaded by HHS, recommend that schools mandate physical education for each school level to improve overall student health (USDHHS, 1996, 2000). The CDC also regularly issues publications emphasizing the need for physical education classes to increase physical activity and health of school-aged children.

Additionally, as part of the reauthorization of the Child Nutrition and Women Infants and Children (WIC) in 2004, the House and Senate mandated that by the 2006-2007 school year, every public school receiving school breakfast and lunch funding must establish a local school wellness policy. Each school policy must include school-level goals for physical activity and nutritional education intended to reduce childhood obesity, establish a healthy school food environment, and prevent diet-related chronic disease. The model local school wellness policy promoted by the National Alliance for Nutrition and Activity (NANA) recommends that daily physical activity be incorporated into the school curriculum for all students in grades K-12 for an equivalent of 225 minutes per week for middle and high school students, with 50% of that class time being MVPA

(NANA, 2008). However, the actual Congressional mandate contains no specific requirements for frequency or intensity of P.E.

The policy battle for increasing (or maintaining) P.E. courses in schools lies in finding sufficient funds to secure needed curriculum time, materials and resources, facilities, and qualified instructors. Current avenues for funding lie primarily in expanding funding for the Carol M. White Physical Education Program (PEP) and funding of physical activity in before- and after-school programs in the 21st Century Community Learning Centers initiative, both housed in the U.S. Department of Education (Clymer, 2008). An additional funding mechanism is within the Child Nutrition and WIC Reauthorization Act in order to fund the currently unfunded Local Wellness Policy. The current political climate makes questionable whether or not stakeholders can secure the role of P.E. in school curriculum unless P.E. is shown to impact students' academic performance and, thus, academic outcomes.

Many factors underlie the dearth of definitive studies on the effectiveness of P.E., in particular its duration and intensity as measured by moderate or high levels in relation to academic performance and academic outcomes. Making P.E. a low priority in schools, evidenced through such policies as not assigning a grade for performance in P.E., likely negatively affects engagement in P.E. and thus restricts the chance for P.E. to positively impact students' school day (Trudeau & Shephard, 2008). Overall, the literature suggests that P.E. may not only positively affect physical fitness and health, but also academic achievement. However, missing in the research are studies using national datasets to determine presence of a direct connection between P.E. and traditional valued measures of academic performance (Trudeau & Shephard, 2008).

Conceptual Framework and Hypotheses

This study seeks to determine whether or not there is a relationship between level of P.E. participation (none, moderate, or high) and academic performance and health outcomes. Figure 1 displays the potential positive pathway of physical education enhancing academic and physical health outcomes. However, Figure 2 offers an alternative framework of a potential negative pathway of physical education harming academic outcomes by decreasing amount of time spent in academic subjects. Determining whether P.E. results in more positive or more negative outcomes could determine the role and funding of P.E. in adolescents' school day, and distinguishing the effects of moderate P.E. versus high levels of P.E. could identify the most effective level of P.E. to incorporate into the curriculum.

Physical education has been shown to improve adolescents' health status, particularly by increasing number of bouts of MVPA per week (Popkin, Duffey, & Gordon-Larsen, 2005). Increased caloric expenditure results in lower body mass index (BMI) in the energy balance equation, assuming that caloric intake is constant. Therefore, participation in P.E. may improve health status by increasing number of MVPA bouts per week and lowering body mass index (BMI), an indicator of health status.

Improved health status and physical activity have been shown to have cognitive benefits, including increased alertness, concentration, memory, and intellectual performance (Strong et al., 2005). Therefore, improved health status prompted by in-school P.E. may increase students' academic performance as measured by self-reported attention in class. This may also be associated with improved grades in core courses

(English, mathematics, science, and history) and improved performance on verbal cognitive tasks. Finally, these improved academic performance outcomes may be associated with increased educational attainment.

Therefore, it is hypothesized that increased frequency and duration of in-school physical education, as measured by moderate and high levels of P.E., will be associated with improved health status as measured by lowered BMI. In turn, this will be associated with improved academic performance measured by increased in-class attention, improved grades, and improved cognitive scores. Finally, this improved academic performance will be associated with increased educational attainment.

Methodology

Data Source

Data were analyzed from the public-use data available from The National Longitudinal Study of Adolescent Health (Add Health) dataset, which originated in 1994 at the Carolina Population Center of the University of North Carolina at Chapel Hill in response to a U.S. Congressional mandate to study adolescent health (Harris et al., 2008). The full dataset sample was 80 high schools and 52 middle schools in the U.S. The criteria for high school selection were that schools include an eleventh grade and have at least 30 students per grade; the criteria for each middle school were to include a seventh grade and be a feeder school (i.e., transmit students) to a high school within the sample. Schools were then stratified into 80 clusters based on region, urbanicity, school type, grade span, curriculum type, percent black student population, and percent white student population. The public-use dataset used in the present study includes approximately

6,500 adolescents of the more than 90,000 adolescents in the full restricted use dataset. The respondents included were one-half of the core sample chosen at random and one-half of the oversample of African American students whose parents had a college degree.

Data were compiled from three waves of interviews conducted in each adolescent's home. Surveys began in Wave 1 with an in-school questionnaire of all students in grades seven to 12 in each school, with follow-up through in-home interviews in 1994-95, 1996, 2001-02, and 2007-08. In addition to student questionnaires, surveys were also gathered from parents, siblings, fellow students, romantic partners, and school administrators. Information about neighborhoods and communities was pulled from other databases.

Waves 1 and 2, conducted in the years 1994-1995 and 1996 respectively, focused on influences on adolescents' health behaviors, including those within the context of personal traits, family, peers, schools, neighborhoods, and communities. In the full dataset, 27,000 adolescents were randomly selected from the Wave 1 in-school interview to participate in the in-home interview, with oversampling of certain populations, such as ethnic minorities. Adolescents were on average 14.46 years in Wave 1 and 16.38 years in Wave 2. Response rates for Waves 1 and 2 were 78.9% and 77.4%, respectively. Wave 3, when participants were 18 to 26 years old, focused on adolescents' transition into adulthood and the accompanying changes in behaviors, decisions, and health outcomes; response rate was 77.5%. Wave 4, when participants were 24 to 32 years old, had not been published at time of present analysis and is not included in this analysis.

Sample Weights and Clustering

Certain groups of adolescents were oversampled for the Add Health dataset. Oversamples were based on ethnicity, saturation, disability status, and genetics. For ethnicity, four supplementary ethnic-group samples were drawn to oversample African American students from well-educated families, as well as Chinese, Cuban, and Puerto Rican students. For saturation oversampling, sixteen schools had all enrolled students selected for in-home interviews in order to analyze social networks. For disability status, 489 students self-reported as having a physical disability involving their limb. For genetic oversampling, identical twins, fraternal twins, half siblings, step-siblings, foster children, and adopted siblings were oversampled in order to analyze the extent of environmental influences on behavior shared by siblings.

In order to account for the oversampling, grand sample weight variables were used in the present analysis in order to more accurately portray a nationally representative sample. Design effects were corrected for by incorporating the most recently available sampling weight variable, which was the grand sample weight from Wave 2. Accounting for weight ensured that the point estimates (means and regression parameters) and variance estimates were accurate.

The sample of 80 high schools and 52 middle schools was chosen with unequal probability of selection. Therefore, systematic sampling methods and implicit stratification ensure that the sample is representative of U.S. schools by considering region, urbanicity, school size, school type, and ethnicity. However, the cluster variable, or primary sampling unit, of the school identifier was unavailable in the public-use dataset and thus could not be included. Therefore, the variance estimates, including standard errors and confidence intervals, may be inaccurate. Further information about the research design of Add Health is available for review by Harris and colleagues (2008).

Exclusion Criteria

Because the analyses are contingent on students attending public school, only students who were enrolled in public school in the 1994-1995 school year were included in the present analysis in order to focus on the normal population of school-aged students. Participants who answered in Wave 1 that they have had difficulty using a limb because of a physical condition lasting 12 months or more were excluded, since this population may require special physical education needs above and beyond the physically able population. To address problems of missing data, the researcher employed case exclusion to include only participants who had full data for important variables in the models, including those missing values of dependent variables.

Dependent Variables of Interest

Academic Performance

The primary dependent variable of interest in the present analysis was academic performance, which was analyzed separately by four measures: attention (self-reported attention in class), academic achievement (self-reported grades in four core subjects), academic attainment (self-reported years of school completed), and cognitive performance (standardized score from an abridged version of the Peabody Picture Vocabulary Test).

Attention. Attention was self-reported on a four point Likert scale in answer to the question, "Since school started this year, how often have you had trouble paying attention in class?" Responses were coded as: 0 for never, 1 for just a few times, 2 for about once a week, 3 for almost every day, and 4 for refused. Attention was available for Waves 1 and 2, which were the time periods in which all participants were enrolled in school. Attention was presented in raw form for the sample description in Table 1 but was converted to z scores in all analyses.

Academic achievement (GPA). Academic achievement was a calculated composite grade point average (GPA) of the student's self-reported grades for mathematics, English, science, and history for the prior term at school. GPA was a continuous variable bounded between 0.0 and 4.0, where 0.0 indicates failing and 4.0 indicates an A for highest performance. GPA was available at Waves 1 and 2, during which all participants were enrolled in school.

Academic attainment. Academic attainment was a continuous variable of self-reported years of education. This variable was measured at Waves 1, 2, and 3.

Cognitive performance (PPVT score). Cognitive performance was measured by the adolescent's score on the Abridged Peabody Picture Vocabulary Test administered at Waves 1 and 3. This is a revised and abbreviated version of the Peabody Picture Vocabulary Test (PPVT). The PPVT involves the interviewer reading aloud a word, after which the respondent selects the illustration out of four simple, black-and-white illustrations in multiple-choice format that best fits the word. The abridged test was composed of 87 items, and raw scores were standardized by age, providing a standardized measure of a respondent's vocabulary and verbal competence. The PPVT has shown high internal consistency (Cronbach's alpha of .93), test-retest reliability of .92, and high concurrent validity with other intelligence tests for children and adolescents, including the Wechsler Intelligence Scale for Children-Third Edition (correlation coefficients ranging from .82 to .92) (Dunn & Dunn, 2007). Cognitive performance was presented in raw form for the sample description in Table 1 but was converted to *z* scores in all analyses.

Health Status

Body mass index (BMI). The secondary dependent variable of interest was health status, which was measured as BMI based on self-reported height and weight. BMI was calculated according to the following formula developed by the Centers for Disease Control and Prevention (CDC): BMI = [weight (lb) / height $(in)^2$] × 703. According to charts developed by the CDC, a BMI score of 18 to 25 is considered normal weight, whereas a BMI score over 25 is considered overweight. Although it is typical for BMI score to be converted into BMI percentile when assessing children and adolescents, because the longitudinal nature of this study meant that by Wave 3 the participants were no longer adolescents, the health status indicator was analyzed as BMI score for each wave. BMI was a continuous variable and was collected at Waves 1, 2, and 3.

Independent Variables of Interest

Physical Education: High, Moderate, or None

P.E. was classified as high, moderate, or none, based on a composite of the frequency and intensity of P.E. Levels of physical education were distinguished based on days per week of P.E. and the minutes of moderate to vigorous activity the student reported engaging in during a typical daily P.E. class. These levels were separated into three categories: 1) none, which included no days or no minutes of physical activity within P.E.; 2) moderate, which included one to four days per week or more than zero but less than 30 minutes of physical activity within P.E.; and 3) high, which included the maximum number of five days and maximum amount of more than 30 minutes of daily physical activity within P.E. P.E. (high, moderate, or none) was coded as a binary variable, where each student was coded as 1 or 0 depending on which level applied to the student.

The levels of high, moderate, or no P.E. were calculated based on students' self-reported frequency and intensity of P.E. Frequency of P.E. was self-reported as the number of days of P.E. attended per school week, and intensity was measured by self-reported amount of minutes spent "actually exercising or playing sports" per P.E. class chosen from five ordinal categories (zero minutes, fewer than 10 minutes, 10 to 20 minutes, 21 to 30 minutes, and more than 30 minutes). For additional comparison, total moderate to vigorous activity (MVPA) in P.E. each week was calculated for descriptive purposes by multiplying frequency of P.E. by average daily intensity of P.E (intensity was converted into 5 minutes for level 1, 15 minutes for level 2, 25 minutes for level 3, and 35 minutes for level 4).

Covariates

Covariates were included in the regression models in order to control for the effects of age, race/ethnicity, gender, poverty, maternal education, and total physical activity.

Gender. Gender was self-reported as male or female. Male was a binary variable that equaled 1 if student was male and 0 if student was female.

Race and ethnicity. Race was selected from the choices of Caucasian, African American, American Indian, Asian or Pacific Islander, and Other. Race was a binary variable that equaled 1 if student self-reported as that race and 0 otherwise. Caucasian was the excluded category of comparison. As an additional measure of ethnicity, Hispanic was included as a binary variable that equaled 1 if a student self-reported as Hispanic and 0 otherwise.

Socio-economic status. Socio-economic status was approximated using a poverty indicator and maternal education. The poverty ratio was calculated from total household income at Wave 1 and was translated into a percentage of the 100% poverty line according to the Department of Health and Human Services formula for the year 1994, which was $ 7360 + 2480(*n*-1), where *n* is the number of total household members (USDHHS, 2009). Maternal education was included as an additional control for socio-economic status. This was a binary variable where 1 equaled high maternal education, earning beyond a high school diploma, and 0 equaled low maternal education, earning a high school diploma, General Educational Development test (GED), or less.

Total physical activity. Total physical activity controlled for physical activity in addition to P.E. in order to separate the effects of physical activity during P.E. compared to during external activities. This variable was measured by total minutes of moderate to vigorous physical activity during the prior week. High total physical activity was a binary variable, where 1 equaled a student had exercised on 3 or more times during the past week. Examples of exercise included jogging, walking, karate, jumping rope, gymnastics, or dancing.

Prior outcomes. Prior student outcomes (attention, GPA, educational attainment, PPVT score, and BMI) were included in regression analyses for outcomes in Waves 2 and 3 to control for student performance not attributed to physical education.

Analysis Plan

Because the frequency and intensity of P.E. resulted in three approximately equal groups of no P.E., moderate P.E., and high P.E., the analyses were conducted as a quasi-experiment to compare the three groups. This allowed each participant to be assigned to a condition based on self-reported level of P.E. In order to examine the effect of these three levels of P.E. on the academic and health variables of interest, ordinary least squares (OLS) linear regressions were analyzed. OLS allowed the investigation of the effect of physical education on each of the academic and health outcomes, while controlling for variables including age, race/ethnicity, gender, poverty ratio, maternal education, and total self-reported physical activity. All analyses were conducted using the statistical package STATA Version 10.

Regression Models

For each dependent variable, four regression models were analyzed for each wave. For all regressions, Model 1 compared moderate P.E. and high P.E. to the excluded category of no P.E.; Model 2 compared high P.E. and no P.E. to the excluded category of moderate P.E. Also, for each model, one regression was limited to the P.E. variables, and one full model included all covariates. Therefore, for each dependent variable at each wave, there were four regression models.

At Wave 1, the covariates included student characteristics (age, race/ethnicity, gender, poverty ratio, maternal education, and total self-reported physical activity). The P.E. variable was student P.E. at Wave 1. At Waves 2 and 3, the covariates included the student characteristics plus the student prior outcomes from Wave 1 (attention, GPA, educational attainment, PPVT score, and BMI). For Wave 2, the P.E. variable was student P.E. at Wave 2. For Wave 3, two sets of analyses were run. The first analyzed student P.E. at Wave 2. The second analyzed the average of student P.E. across Wave 1 and Wave 2 in order to examine the effects of P.E. throughout middle and high school on adolescents' later outcomes.

Linear regression analyses assessed the effect of P.E. and control variables on academic and health dependent variables of interests. The following formula was used for each set of analyses, where DV is the dependent variable and indicates separate regressions for each academic outcome (attention, academic achievement, cognitive performance, or educational attainment) or health outcome (body mass index):

Model 1

DV = High P.E. + Some P.E. + Age + Male + Poverty Ratio + High Maternal Education + African American + American Indian + Asian + Other + Hispanic + High Total Physical Activity

Model 2

DV = High P.E. + No P.E. + Age + Male + Poverty Ratio + High Maternal Education + African American + American Indian + Asian + Other + Hispanic + High Total Physical Activity

Results

Descriptive Statistics of Adolescents

Demographic, health, and academic descriptive statistics were calculated for the sample population for Waves 1, 2, and 3 (see Table 1). The mean age was 14.46 years (SD = 0.01) in Wave 1 (1994 to 1995), 16.38 years (SD = 0.04) in Wave 2 (1996), and

21.21 years (SD = 0.05) in Wave 3 (2001 to 2002). Based on the first wave, the sample was majority female (51.25%) and predominantly self-classified as Caucasian (71.50% in Wave 1), followed by African American (17.40%), with smaller numbers of American Indian (3.75%), American Indian or Pacific Islander (3.93%), and "Other" (8.10%). In Wave 1, 13.38% of the sample was Hispanic. On average the participants' household income was 2.88 times the poverty level (SD = 0.11). Maternal education indicated that 43.74% of adolescents' mothers had higher than a high school diploma.

Academic Performance of Sample of Adolescents

On average participants had 8.84 years of education in Wave 1 (SD = 0.05); approximately one year later the average educational attainment was 9.52 (SD = 0.05), and five years later the educational attainment had increased to 12.95 (SD = 0.06). Average academic performance in core academic subjects (mathematics, English, history, science) in Wave 1 was 2.86 which averages to a C+ average (SD = 0.02) and a similar 2.84 in Wave 2 (SD = 0.02), which is also a C+ average. The raw score on the Abridged Peabody Picture Vocabulary Test was 63.89 in Wave 1 (SD = 0.33), which increased to 104.40 in Wave 3 (SD = 6.23). Finally, self-reported attention in class remained about the same, 1.19 (SD = 0.03) in Wave 1 and 1.10 (SD = 0.03) in Wave 2, which both equate to "just a few times" of having trouble paying attention in class since the school year had started.

Health Status of Sample of Adolescents

Descriptive statistics of health measures reveal that the sample mean weight was 137.90 pounds (SD = 1.02) in Wave 1, increased to 145.42 pounds (SD = 1.09) in Wave 2, and increased to 167.50 pounds (SD = 1.41) in Wave 3. Correspondingly, the mean

BMI increased from 22.31 (SD = 0.13) to 22.94 (SD = 0.15) in Wave 2, both of which are classified as normal weight. However, in Wave 3, participants on average had a BMI of 25.68 (SD = 0.18), which is classified as overweight.

Typical physical activity in P.E. Most students in both Waves 1 had moderate P.E. (40.33%), followed by no P.E. (32.70%), with the least number of students having high P.E. (26.97%). One year later in Wave 2, the most students had no P.E. (43.35%), followed by moderate P.E. (36.98%), followed by no P.E. (19.67%). See Tables 2 and 3 for a cross-tabulation of frequency of P.E. by intensity of P.E. during each wave.

On average, participants had 2.83 days (SD = 0.06) of P.E. per week in Wave 1 and 2.31 days (SD = 0.08) of P.E. per week in Wave 2. The total minutes of moderate to vigorous physical activity (MVPA) per week in P.E. also slightly declined, from 121.73 minutes (SD = 1.80) in Wave 1 to 116.78 minutes (SD = 2.34) in Wave 2. The intensity of P.E. was categorized into four ordinal categories based on duration of MVPA. In Wave I, the majority of students participated in more than 30 minutes of MVPA per P.E. class (39.42%), followed by 0 minutes of MVPA (32.70%), 21 to 30 minutes (18.07%), 10 to 20 minutes (7.08%), and finally fewer than 10 minutes (2.73%). In Wave II, the majority of students participated in 0 minutes of MVPA within P.E. (43.35%), followed by more than 30 minutes (32.90%), 21 to 30 minutes (14.79%), 10 to 20 minutes (6.73%), and 1 to 10 minutes (2.24%). This indicates that when the adolescents were slightly older in Wave 2, they had fewer days, fewer minutes of MVPA, and less intensity of physical activity compared to their prior P.E. during Wave 1.

P.E. intensity, frequency, and total MVPA were significantly correlated with their counterpart at Waves 1 and 2, $r = 0.3352$ for intensity, $r = .2656$ for frequency, and

$r = .1239$ for MVPA. However, intensity and frequency were not correlated with each other at Wave 1 or at Wave 2, indicating that students who had P.E. more often did not necessarily have higher MVPA intensity.

Linear Regression Results

Effects on Academic Performance

Attention. The effects of P.E. on attention problems were investigated at Wave 1. Model 1, including moderate and high P.E. compared to the excluded category of no P.E., revealed that moderate P.E. predicted significantly fewer attention problems than no P.E. ($p = 0.005$). This was still seen as a marginal effect when controlling for covariates of student characteristics ($p = 0.056$). Model 2, comparing high P.E. to the excluded category of moderate P.E., revealed that students with high levels of P.E. reported more attention problems than those with moderate P.E. ($p = 0.010$). This relationship was still seen with covariates, where high P.E. significantly predicted more attention problems ($p = 0.028$) than moderate P.E. See Table 4.

In Wave 2, high P.E. marginally predicted fewer attention problems than no P.E. ($p = 0.061$), although this did not hold true in the model with covariates. Students with high P.E. reported fewer attention problems than students with moderate P.E. ($p = 0.019$), which also held true with covariates ($p = 0.009$). See Table 5.

Academic performance (GPA). In Wave 1, there was no statistically significant effect of P.E. on GPA until controlling for covariates, which revealed that moderate and high P.E. both marginally predicted lower GPA ($p = 0.070$ for moderate, $p = 0.066$ for high). See Table 6. In model 2, there was no statistically significant difference between moderate and high P.E.

In Wave 2, moderate and high P.E. predicted lower GPA than no P.E. (p = 0.009 for moderate, p = 0.040 for high), and this held true with covariates of student characteristics and prior outcomes (p = 0.033 for moderate, p = 0.055 for high). No P.E. predicted higher GPA than moderate P.E. (p = 0.009), which also held true with covariates (p = 0.033). See Table 7.

Educational attainment. In Wave 1, moderate P.E. and high P.E. predicted lower years of educational attainment than no P.E. (p = 0.000 for both). With covariates, moderate P.E. still significantly predicted lower years of educational attainment (p = 0.000), but this was no longer seen for high P.E. In Model 2, high P.E. marginally predicted more years of education (p = 0.071) than moderate P.E. This held true when controlling for covariates, so that high P.E. significantly predicted more years of education than moderate P.E. (p = 0.013). See Table 8.

In Wave 2, moderate and high P.E. predicted lower educational attainment than no P.E. (p = 0.000 for both). With covariates, moderate P.E. still marginally predicted lower educational attainment than no P.E. (p = 0.080). There was no statistically significant difference between moderate and high P.E. See Table 9.

In Wave 3, using P.E. information from Wave 2, high P.E. marginally predicted fewer years of education than no P.E. (p = 0.066). However, when accounting for covariates of student characteristics and prior outcomes, moderate P.E. predicted higher educational attainment than no P.E. (p = 0.011). There was no statistically significant difference between high or moderate P.E. See Table 10. In Wave 3, using the average P.E. across Waves 1 and 2, high and moderate P.E. predicted fewer years of education than no P.E. (p = 0.003 for high, p = 0.038 for moderate). However, this was not seen when including covariates. There was no statistically significant difference between high and moderate P.E. See Table 11.

Cognitive performance (PPVT score). In Wave 1, moderate and high P.E. predicted lower PPVT scores ($p = 0.002$ for moderate, $p = 0.000$ for high), but this was no longer significant when controlling for covariates. See Table 12. There was no statistically significant difference between moderate and high P.E.

In Wave 3, there was no significant effect of moderate or high P.E. during Wave 2 on PPVT scores with and without covariates. There was also no statistically significant difference between moderate and high P.E. with or without covariates. See Table 13. In Wave 3, using average P.E. from Waves 1 and 2, there was no significant effect of P.E. on PPVT scores with or without covariates. There was no statistically significant difference between high or moderate P.E. See Table 14.

Effects on Health Status.

In Wave 1, moderate P.E. significantly predicted -0.79 lower body mass index ($p = 0.031$). With student characteristic covariates, there was no longer a significant effect of P.E. on BMI. See Table 15. There was no statistically significant difference between moderate and high P.E. in Model 2.

In Wave 2, moderate P.E. significantly predicted -0.85 lower BMI than no P.E. ($p = 0.018$), which did not hold true when covariates where included. See Table 16. There was no statistically significant difference between moderate and high P.E., with or without covariates.

In Wave 3, moderate P.E. during Wave 2 predicted -1.17 lower BMI compared to having no P.E. ($p = 0.014$); this became marginal when including covariates ($p = 0.081$).

See Table 17. There was no statistically significant difference between moderate and high P.E., with or without covariates. In Wave 3, using average P.E. from Waves 1 and 2, moderate P.E. predicted lower BMI than no P.E. ($p = 0.046$). This was also seen when including covariates of student characteristics and outcomes, where moderate P.E. predicted lower BMI than no P.E. ($p = 0.046$). See Table 18. There was no statistically significant difference between high or moderate P.E., with or without covariates.

Discussion

Physical education was revealed to reduce problems of in-class attention. During middle school and high school, students who had moderate to vigorous activity during P.E. class reported fewer in-class attention problems than those who had no P.E. In Wave 1, this relationship only held true for moderate P.E., where students with moderate P.E. reported fewer attention problems than high or no P.E. Yet in Wave 2, the trend reversed so that high P.E. related to fewer attention problems compared to moderate or no P.E. This points to a potential interaction with age, where moderate levels of P.E. reduce attention problems among adolescents when they are younger, but in the second wave two years later, higher levels of P.E. benefit attention.

There did appear to be negative effects of P.E. on students' academic outcomes. Being physically active in P.E. class predicted lower grade point average compared to no P.E., seen in both Waves 1 and 2. This finding of P.E. associated with lower GPA contradicts a previous study of the same dataset that shows that higher in-school physical activity was associated with higher grades, in particular for mathematics and for English (Nelson & Gordon-Larsen, 2006). Because the present analysis examined the cumulative

GPA across four core subjects, it may have masked benefits for particular courses such as mathematics and English. Additionally, different results may be revealed when examining the full dataset rather than the sub-set of adolescents in the public-use dataset.

It appears in this analysis that adolescents who were physically active in P.E. did have lower academic performance measured by GPA, although there was no difference in whether that P.E. is moderate or high. It is unclear whether or not the lower GPA is due to decreased time in core academic subjects, as is posited in the negative pathways model. There may be inherent differences, including academic achievement, that distinguish students who participate in P.E. from students who do not participate in P.E.; therefore this model may inaccurately point to P.E. as the causal factor in lowered GPA. Also, it may be that students who are less academically inclined more often enroll in P.E., in which case the model could be understating the effects of P.E. on GPA if lower performing students self-select into P.E.

Physical activity in P.E. was also related to lower PPVT scores during Wave 1, but this was no longer statistically significant when controlling for covariates. Therefore, there seem to be other factors at play, including age, gender, poverty, and maternal education, that explain the lowered PPVT score once covariates are included. These other factors may also mean an adolescent is less likely to enroll or be physically active in P.E. There was no statistically significant effect of P.E. on PPVT scores during Wave 3, implying that any negative effects seen in Wave 1 diminished to non-significance within a few years time. In both the case of GPA and the PPVT score, it is unknown whether it is the P.E. causing these lowered academic outcomes or perhaps external factors, such as students with lower academic outcomes choosing to enroll in P.E.

whereas students with higher academic outcomes do not. Because the analyses are no longer significant when covariates are included for PPVT, it appears that these other attributes of the adolescent are at least partially to blame for lowered PPVT score.

P.E. tended to predict lower years of educational attainment during the first and second waves. However, in Wave 3, accounting for student characteristics and prior outcomes, moderate P.E. did produce more years of educational attainment than no P.E. Also, high P.E. predicted higher levels of education compared to moderate P.E. at Wave 1. Otherwise there was no difference between high and moderate P.E. in subsequent waves. The trend for higher years of education during Waves 1 and 2 to be associated with no P.E. may reflect school policies that require more frequent P.E. for younger students than older students. This negative academic outcome of P.E. may also reflect a decreasing tendency to enroll in P.E. classes as adolescents grow older, perhaps due to increased focus on academic courses or decreased desire for in-school physical activity. The fact that the trend reversed at Wave 3, when participants were out of public school and attaining education beyond high school, indicates that there may in fact be a positive relationship between P.E. and later educational attainment.

There also appeared to be a positive effect of P.E. on lowered body mass index across all three waves, and this trend was strongest for Wave 3. In particular, having moderate P.E. was related to lower BMI scores in waves 1, 2, and 3, and there was no difference between the effects of moderate or high P.E. on BMI. This indicates that having even a moderate amount of P.E. with at least a minimal portion of time spent in moderate to vigorous activity may produce lowered body mass index, which would decrease students' health risks and decrease overweight. Considering participants were on average overweight by Wave 3, the fact that those students who participated in P.E. had lower BMI than those students who were not active in P.E. is promising for curbing obesity rates. This is particularly promising considering that decreased BMI was evident even at Wave 3, which was five years or more after the participants were no longer in P.E. class. In addition to the benefit of lower BMI, this healthier weight status may also have implications for improved cognitive functioning.

It is clear that these findings indicate that P.E. has a beneficial effect on reducing attention problems, increasing post-high school educational attainment, and lowering BMI. However, there were mixed findings on the benefits or drawbacks of moderate versus high P.E. Specifically, moderate P.E. was more beneficial in reducing attention problems at Wave 1, but high P.E. was more beneficial than no or moderate P.E. for attention at Wave 2. High P.E. was more beneficial for educational attainment than moderate P.E. at Wave 1, but there were no differences in the other waves. Moderate P.E. had a significant effect on reduced BMI, yet there was no difference between moderate and high P.E. Finally, there was no difference between moderate and high P.E. for GPA or for PPVT scores.

Thus, it appears that the benefits of reduced attention problems and lowered BMI are seen even at moderate levels of P.E. With a more fine-tuned analysis of the particular levels of intensity and frequency of P.E., it could be analyzed whether or not a gradual increase in P.E. could produce more beneficial outcomes. It is unclear whether or not increased intensity and frequency of P.E. would result in improved academic and health outcomes, but it is evident that any P.E. does reduce attention problems, does positively increase post-high school educational attainment, and does lower BMI. It may be that the actual activities spent during the P.E. class time are the crucial factors to whether or not P.E. benefits, harms, or does not affect academic outcomes. Simply having several days of P.E. per week without high levels of intensity, i.e., moderate to vigorous activity, may not produce the beneficial outcomes attributed to aerobic activity and may in fact contribute to the lower GPA seen among adolescents in P.E.

A strength of this analysis is that it employed a quasi-experimental design in which each participant was assigned to one of three conditions (no, moderate, or high P.E.) based on self-reported intensity and frequency of weekly P.E. Although not the gold standard of random assignment, the quasi-experiment allows for survey data to become close to a true experiment by creating groups of comparison so that three levels of the independent variable of interest, i.e. physical education, could be compared while controlling for individual characteristics.

Additionally, this analysis was a longitudinal design investigating eight years of data collected at three time points across participants' adolescence and early adulthood. The longitudinal data allowed for an examination of the effect of P.E. not only on concurrent outcomes but also outcomes five years later during Wave 3. Also, by including a broad range of students from varied racial and socio-economic backgrounds, as well as including weighting variables in order to make the sample representative of the population of U.S. adolescents, the findings of this analysis should hold for youth across the country. Therefore, this study provides evidence of connections between P.E. and reduced attention problems, increased educational attainment, and lowered BMI for a wide range of U.S. youth.

Limitations

A limitation of this analysis is the potential of selection bias where the students who did or did not elect to enroll in physical education, or those who participated in more or less intense physical activity, have unobservable characteristics that cause them to select higher or lower amounts of P.E. For instance, motivated students who wish to perform well academically may also be motivated to perform well athletically, thus more likely to be enrolled in P.E. and have high cognitive performance seen in attention in class. Conversely, these students may choose additional academic courses at the expense of physical education courses; thus students with higher cognitive performance may be less likely to be enrolled in P.E. Also, it could be that students who are less academically oriented may be more likely to enroll in P.E., and thus the positive effects on reducing in-class attention problems seen in this analysis may in fact be understated since those in P.E. may have lower cognitive performance than those not in P.E. For now the relationship appears ambiguous. Further research is needed to determine the reasons that adolescents are (or are not) selecting to enroll in P.E. and how they are choosing whether or not to be physically active during that class time.

In examining health status, adolescents who are already fit and inclined towards physical activity may be more likely to enroll in P.E. and more likely to be moderately to vigorously active. Therefore, the positive effects of P.E. on health status may be overstated because adolescents who are already of healthy weight may be more likely to enroll in P.E. Again, this relationship is unclear because it is unknown why students choose to enroll in P.E. and whether or not students who are active in P.E. differ in unobserved ways from students who are not enrolled or not active in P.E.

Another limitation is that these analyses did not take into account clustering based on school due to the restrictions of the public-use dataset. Students from the same school may not be independent in that they are offered the same options or requirements for P.E., and they may have the same P.E. teachers who require certain amounts of physical activity each day. Furthermore, students who attend the same school may have other shared but unobserved attributes, such as access to recreational facilities, nutritious foods, honors classes, and after-school programs that may affect their academic and health outcomes. Therefore, accounting for clustering based on school is necessary to take into account the school effects independent of the individual.

Future Directions

These analyses were conducted using three waves of longitudinal surveys. Although a quasi-experimental design was employed in order to compare students by no, moderate, and high P.E., these students were not randomly assigned to these three conditions, and thus there are many potential unobservable characteristics that may be contributing to the findings. Each of the findings warrants further study in order to determine whether or not P.E. is a causal factor for each academic and health outcome.

Because the Add Health dataset was designed as a cluster sample in which schools were selected with unequal probability and student observations were not independent and identically distributed, the cluster variable is needed to account for this lack of randomization. Because it was not possible to account for the school identifier clustering variable in the public-use dataset, the estimates of variances, standard errors, and confidence intervals may be inaccurate. Securing access to the restricted-use dataset would make clustering identification available; thus analyzing the full dataset is a recommended future direction.

In addition to the need for analyzing the full dataset, a second recommendation is to account for each student's academic workload in order to test the negative pathway of whether or not increased P.E. reduces academic class time and thus negatively affects students' academic performance. If academic workload is not affected by frequent bouts of P.E. and if students who have high amounts of P.E. still perform as high or higher than those who have lower amounts (or no amount) of P.E. but more academic class time, then the negative pathway would be challenged.

Conclusion

The results from these analyses partially support the positive pathways framework in Figure 1 and the proposed hypotheses. Moderate P.E. was associated with improved health status. Moderate P.E. and high P.E. were also associated with decreases in-class attention problems and increased years of educational attainment after high school graduation. However, there was no support that P.E. was associated with improved academic performance or cognitive performance. In fact, there appeared to be negative effects of P.E. on academic performance as measured by grade point average, although it is unclear whether this is a direct causal pathway or if there are mediators that account for these negative outcomes. There did not appear to be a harmful effect of P.E. on cognitive performance measured by a standardized test. Therefore, the positive pathways framework is partially supported, but questions still remain about the extent to which P.E. positively affects academic performance.

Research indicates that physical activity improves students' academic skills in the areas of learning, concentration, memory, classroom behavior, and general academic performance. These analyses reveal that P.E. has a positive effect on students' in-class attention, years of education, and students' health status with lowered body mass index. These benefits of P.E. warrant further study to examine the extent to which decreased attention problems, increased education, and better health could enhance academic performance. Continued research that connects physical education to academic achievement could validate the need for policies requiring in-school physical activity, which would not only improve health status but potentially improve academic performance of U.S. adolescents.

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Figure 1. Positive pathway of effects of physical education on health status and academic outcomes.

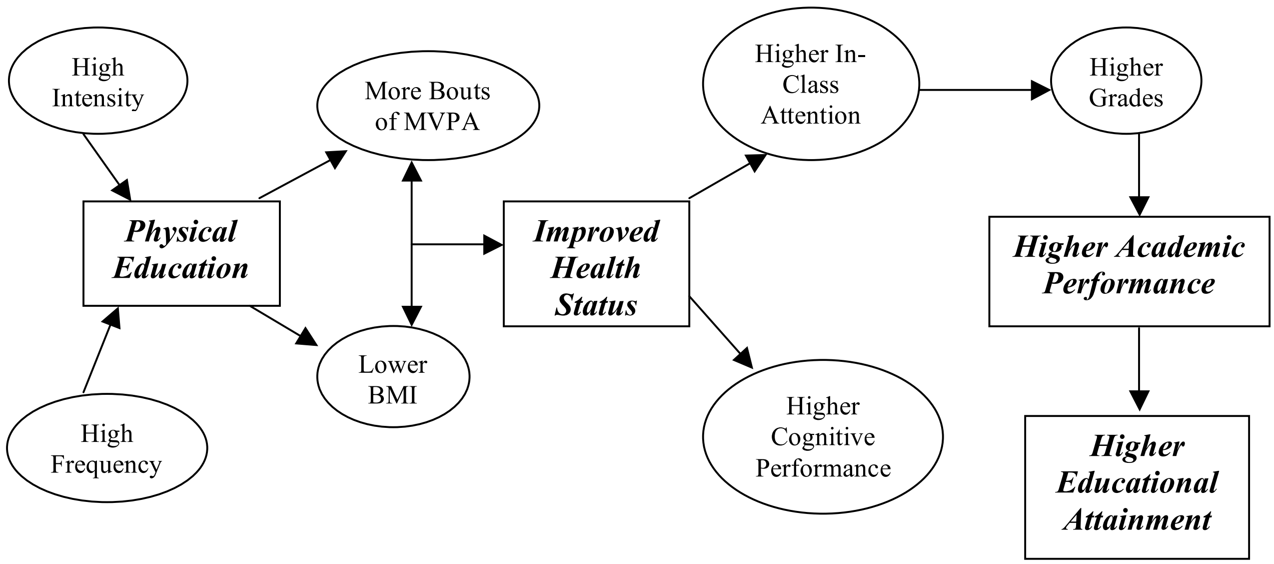

Figure 2. Negative pathway of effects of physical education on academic outcomes.

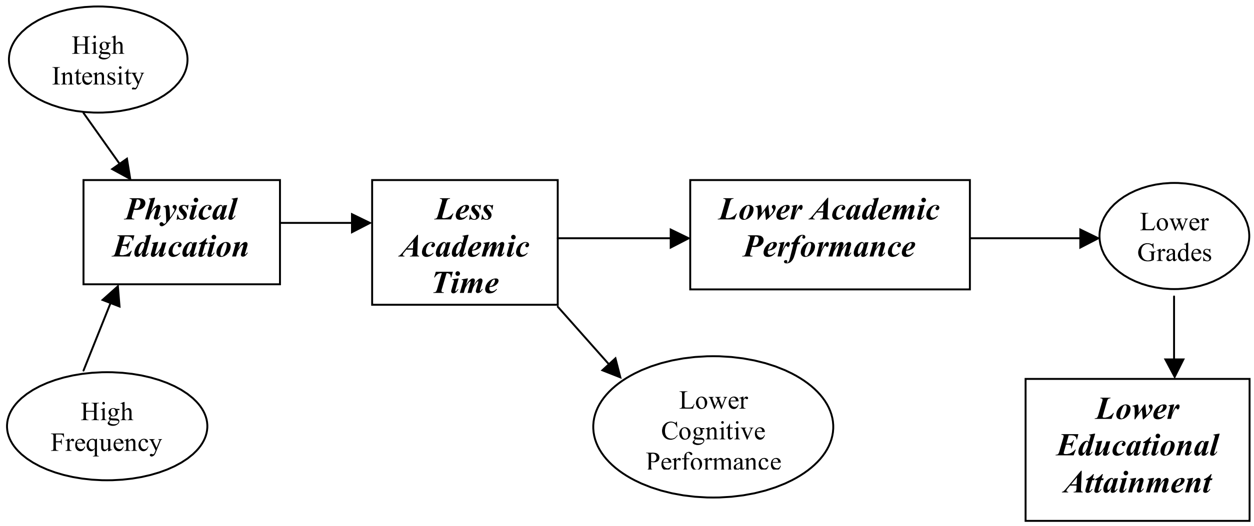

Table 1.

Descriptive Statistics of the Study Population of Adolescents

Variable	1994-1995 (n = 1686) % of Study Population or Mean	(S.D.)	1996 (n = 1616) % of Study Population or Mean	(S.D.)	2001-2002 (n = 1317) % of Study Population or Mean	(S.D.)
Demographics						
Gender						
Male	51.25 %	(0.01)	51.25%	(0.01)	48.08%	(0.02)
Age	14.46	(0.04)	16.38	(0.04)	21.21	(0.05)
Race						
Caucasian	71.50%	(0.01)			77.52%	(0.01)
African American	17.40%	(0.01)			16.96%	(0.01)
American Indian or Native American	3.75%	(0.01)			4.43%	(0.01)
Asian or Pacific Islander	3.93%	(0.01)			4.59%	(0.01)
Other [1]	8.10%	(0.01)				
Hispanic						
Hispanic	13.38%	(0.01)			11.99%	(0.01)
Poverty Ratio[2]	2.88	(0.11)				
Maternal Education (GED or Higher)	43.74%					
Health Status						
Weight	137.90	(1.02)	145.42	(1.09)	167.50	(1.41)
Body Mass Index (BMI) [3]	22.31	(0.13)	22.94	(0.15)	25.68	(0.18)
High Total Physical Activity	50.13%					
In-School Physical Education						
No P.E.	32.70%		29.92%			
Moderate P.E.	40.33%		56.51%			
High P.E.	26.97%		19.67%			
Frequency (days/week) [4]	2.83	(0.06)	2.31	(0.08)		
Intensity (amount of MVPA) [5]						
0 minutes	32.70%		43.35%			
1 to 10 minutes	2.73%		2.24%			
10 to 20 minutes	7.08%		6.73%			
21 to 30 minutes	18.07%		14.79%			
More than 30 minutes	39.42%		32.90%			
Total MVPA per week	121.73	(1.80)	116.78	(2.34)		
Academic Performance						
Self-Reported Attention in Class [6]	1.19	(0.03)	1.10	(0.03)		
Academic Performance (GPA) [7]	2.86	(0.02)	2.84	(0.03)		
Academic Attainment (# years)	8.84	(0.05)	9.52	(0.05)	12.95	(0.06)
Cognitive Performance						
Peabody Picture Vocabulary Test	63.89	(0.33)			104.40	(6.23)

Source: Author's analysis of data from National Longitudinal Study of Adolescent Health, Wave I (1994-5), Wave II (1996), and Wave III (2001-2002).

Notes:
1. “Other” was not an option in Wave 3.
2. Poverty ratio was calculated as the ratio of household income compared to the poverty line established by the U.S. Department of Health and Human Services in 1994.
3. BMI was calculated with the following formula from CDC: (weight in pounds * 703)/(height in inches).
4. Frequency of P.E. had 2206 observations for Wave 1 and 3302 in Wave 2 because only students currently in school answered the question.
5. Intensity of in-school physical education was coded as an ordinal variable in response to the question, “During an average physical education class at school, how many minutes do you spend actually exercising or playing sports?”, where 1 = less than 10 minutes, 2 = 10 to 20 minutes, 3 = 21 to 30 minutes, and 4 = more than 30 minutes. Students who were not currently in school or didn’t know were coded as zero and assumed to have zero minutes of physical activity.
6. Self-reported attention in class was coded as an ordinal variable in response to the question, “Since school started this year, how often have you had trouble paying attention in class?” Responses were coded as: 0 for never, 1 for just a few times, 2 for about once a week, 3 for almost every day, and 4 for refused.
7. GPA was calculated as an ordinal variable, where 4 = A, 3 = B, 2 = C, and 1 = D or lower for grade assigned at most recent grading period. GPA is the average GPA of English, Math, History, and Science. Responses were coded as missing if participant did not take the subject, was not graded according to this grading scale, refused to answer, or did not know.

Table 2. Physical education by intensity and frequency during Wave 1.

	P.E. Frequency – Wave 1 (days per week)					
	0	1	2	3	4	5
P.E. Intensity – Wave 1						
0 min	32.70	0.00	0.00	0.00	0.00	0.00
Less than 10 min	0.00	0.15	0.00	0.48	0.00	1.93
10 to 20 min	0.00	0.45	0.48	1.13	0.00	4.93
21 to 30 min	0.00	0.35	1.58	3.58	0.51	12.03
More than 30 min	0.00	2.71	2.76	6.03	0.95	26.97

Table 3. Physical education by intensity and frequency during Wave 2.

	P.E. Frequency – Wave 2 (days per week)					
	0	1	2	3	4	5
P.E. Intensity – Wave 2						
0 min	43.35	0.00	0.00	0.00	0.00	0.00
Less than 10 min	0.00	0.00	0.00	0.12	0.14	1.90
10 to 20 min	0.00	0.58	0.76	0.66	0.00	4.63
21 to 30 min	0.00	0.91	1.63	2.21	0.26	9.78
More than 30 min	0.00	1.87	3.32	6.72	1.32	19.67

Table 4.

Linear regression predicting determinants of in-class attention problems during Wave 1.

Variable	*B*	*SE B*	*p* value	95% CI
Model 1				
High P.E	0.07	5.40	.990	-10.52 to 10.65
Moderate P.E.	-13.05**	4.60	.005	-22.08 to -4.02
R^2	.009			
Model 2				
High P.E.	13.12*	5.08	.010	3.14 to 23.09
No P.E.	13.05**	4.60	.005	4.02 to 22.08
Model 1 – Covariates				
High P.E.	2.38	5.40	.659	-8.21 to 12.97
Moderate P.E.	-8.87†	4.64	.056	-17.96 to 0.22
Age	3.78*	1.24	.002	1.34 to 6.21
Male	18.83***	3.95	.000	11.08 to 26.59
Poverty Ratio	0.50	0.60	.403	-0.67 to 1.67
Maternal Education	0.69	4.06	.866	-7.28 to 8.65
African American	-11.92*	4.91	.015	-21.55 to -2.29
American Indian	7.24	11.66	.535	-15.64 to 30.12
Asian	-3.98	9.37	.671	-22.38 to 14.41
Other	-21.79*	8.97	.015	-39.39 to -4.20
Hispanic	8.15	8.56	.341	-8.64 to 24.95
High Total Activity	3.07	4.02	.445	-4.81 to 10.95
R^2	.044			
Model 2 – Covariates				
High P.E.	11.25*	5.11	.028	1.23 to 21.27
No P.E.	8.87†	4.64	.056	-0.22 to 17.96

Note. Values are expressed as coefficient. A positive coefficient indicates more attention problems in class. In Model 1, No P.E. is excluded as the comparison variable. In Model 2, Moderate P.E. is excluded as the comparison variable. Model 2 contained all covariates included in Model 1 but is condensed. 95% CI indicates confidence interval. *** = $p < .001$, ** = $p < .01$, * = $p < .05$, † = $p < .10$.

Table 5.

Linear regression predicting determinants of in-class attention problems during Wave 2.

Variable	*B*	*SE B*	*p* value	95% CI
Model 1				
High P.E.	-10.23†	5.46	.061	-20.94 to 0.47
Moderate P.E.	3.77	5.38	.484	-6.78 to 14.32
R^2	.006			
Model 2				
High P.E.	-14.00*	5.98	.019	-25.73 to -2.28
No P.E.	-3.77	5.38	.484	-14.32 to 6.78
Model 1 – Covariates				
High P.E.	-7.07	5.73	.217	-18.31 to 4.17
Moderate P.E.	7.69	5.44	.157	-2.398 to 18.36
Age	0.41	3.51	.907	-6.47 to 7.29
Male	1.41	4.43	.751	-7.29 to 10.10
Poverty Ratio	0.17	0.56	.761	-0.93 to 1.28
Maternal Education	11.08*	4.76	.020	1.75 to 20.42
African American	-13.87*	5.94	.020	-25.52 to -2.23
American Indian	-18.33†	10.54	.082	-39.02 to 2.36
Asian	11.94	16.43	.468	-20.31 to 44.18
Other	-2.94	10.45	.779	-23.43 to 17.56
Hispanic	-0.91	9.66	.925	-19.86 to 18.05
High Total Activity	-6.13	4.37	.162	-14.71 to 2.46
GPA (w.1)	-2.56	1.85	.166	-6.19 to 1.06
Educational Attainment	-1.06	4.21	.801	-9.32 to 7.20
Attention (w.1)	0.28***	0.04	.000	0.21 to 0.35
PPVT (w.1)	-0.03	0.05	.536	-0.13 to 0.07
BMI (w.1)	0.13	0.35	.709	-0.55 to 0.81
R^2	.123			
Model 2 – Covariates				
High P.E.	-14.76**	5.67	.009	-25.88 to -3.64
No P.E.	-7.69	5.44	.157	-18.36 to 2.98

Note. Values are expressed as coefficient. A positive coefficient indicates more attention problems in class. In Model 1, No P.E. is excluded as the comparison variable. In Model 2, Moderate P.E. is excluded as the comparison variable. Model 2 contained all covariates included in Model 1 but is condensed for table. (w.1) indicates variables from Wave 1. 95% CI indicates confidence interval. *** = $p < .001$, ** = $p < .01$, * = $p < .05$, † = $p < .10$.

Table 6.

Linear regression predicting determinants of academic achievement (GPA) during Wave 1.

Variable	*B*	*SE B*	*p* value	95% CI
Model 1				
High P.E.	-0.05	0.10	.606	-0.24 to 0.14
Moderate P.E.	0.03	0.09	.687	-0.13 to 0.20
R^2	.001			
Model 2				
High P.E.	-0.08	0.09	.357	-0.26 to 0.10
Moderate P.E.	-0.03	0.09	.687	-0.20 to 0.13
Model 1 – Covariates				
High P.E.	-0.17†	0.09	.066	-0.36 to 0.01
Moderate P.E.	-0.15†	0.08	.070	-0.32 to 0.01
Age	-0.21***	0.02	.000	-0.25 to -0.16
Male	-0.32***	0.07	.000	-0.45 to -0.18
Poverty Ratio	0.01	0.01	.455	-0.01 to 0.03
Maternal Education	0.35***	0.07	.000	0.21 to 0.50
African American	-0.10	0.07	.192	-0.24 to 0.05
American Indian	-0.30†	0.18	.090	-0.65 to 0.05
Asian	-0.02	0.21	.939	-0.43 to 0.40
Other	-0.07	0.15	.629	-0.37 to 0.22
Hispanic	-0.13	0.12	.257	-0.36 to 0.10
High Total Activity	0.07	0.07	.286	-0.06 to 0.21
R^2	.104			
Model 2 – Covariates				
High P.E.	-0.02	0.09	.808	-0.19 to 0.15
No P.E.	0.15†	0.08	.070	-0.01 to 0.32

Note. Values are expressed as coefficient. In Model 1, No P.E. is excluded as the comparison variable. Model 2 was not reported due to no significance. Model 2 contained all covariates included in Model 1 but is condensed for table. 95% CI indicates confidence interval.
*** = $p < .001$, † = $p < .10$.

Table 7.

Linear regression predicting determinants of academic achievement (GPA) during Wave 2.

Variable	*B*	*SE B*	*p* value	95% CI
Model 1				
High P.E.	-0.18*	0.09	.040	-0.35 to -0.01
Moderate P.E.	-0.17**	0.06	.009	-0.29 to -0.04
R^2	.013			
Model 2				
High P.E.	-0.01	0.08	.885	-0.18 to 0.15
No P.E.	0.17†	0.06	.009	0.04 to 0.29
Model 1 – Covariates				
High P.E.	-0.13†	0.07	.055	-0.26 to 0.00
Moderate P.E.	-0.12*	0.05	.033	-0.22 to -0.01
Age	-0.05	0.04	.215	-0.12 to 0.03
Male	-0.16**	0.05	.001	-0.26 to -0.06
Poverty Ratio	-0.00	0.01	.486	-0.01 to 0.01
Maternal Education	0.16**	0.05	.001	-0.06 to 0.27
African American	-0.25***	0.07	.000	-0.38 to -0.12
American Indian	0.18†	0.11	.091	-0.03 to 0.69
Asian	0.36*	0.17	.032	-0.03 to 0.39
Other	0.06	0.10	.586	-0.15 to 0.26
Hispanic	-0.06	0.09	.524	-0.23 to 0.12
High Total Activity	-0.06	0.05	.220	-0.16 to 0.04
GPA (w.1)	0.23***	0.02	.000	0.18 to 0.28
Educational Attainment	0.05	0.04	.233	-0.03 to 0.13
Attention (w.1)	-0.00**	0.00	.003	-0.00 to -0.00
PPVT (w.1)	0.00**	0.00	.001	0.00 to 0.00
BMI (w.1)	-0.00	0.00	.594	-0.01 to 0.01
R^2	.320			
Model 2 – Covariates				
High P.E.	-0.01	0.07	.857	-0.14 to 0.12
No P.E.	0.12*	0.05	.033	0.01 to 0.22

Note. Values are expressed as coefficient. In Model 1, No P.E. is excluded as the comparison variable. Model 2 was not reported due to no significance. Model 2 contained all covariates included in Model 1 but is condensed for table. (w.1) indicates variables from Wave 1. 95% CI indicates confidence interval. *** = $p < .001$, ** = $p < .01$, * = $p < .05$, † = $p < .10$.

Table 8.

Linear regression predicting determinants of educational attainment during Wave 1.

Variable	*B*	*SE B*	*p* value	95% CI
Model 1				
High P.E.	-0.83***	0.11	.000	-1.05 to -0.62
Moderate P.E.	-1.04***	0.11	.000	-1.25 to -0.82
R^2	.077			
Model 2				
High P.E.	0.20†	0.11	.071	-0.02 to 0.42
No P.E.	1.04***	0.11	.000	0.82 to 1.25
R^2	.077			
Model 1 – Covariates				
High P.E.	-0.12	0.09	.212	-0.30 to 0.07
Moderate P.E.	-0.35***	0.09	.000	-0.53 to -0.16
Age	0.72***	0.04	.000	0.64 to 0.79
Male	-0.16*	0.07	.015	-0.30 to -0.03
Poverty Ratio	0.03**	0.01	.001	0.01 to 0.05
Maternal Education	0.22**	0.07	.003	0.07 to 0.36
African American	-0.08	0.10	.400	-0.27 to 0.11
American Indian	0.14	0.09	.123	-0.04 to -0.31
Asian	-0.12	0.46	.795	-1.02 to -0.78
Other	-0.13	0.12	.290	-0.11 to 0.37
Hispanic	-0.17	0.11	.140	-0.39 to 0.06
High Total Activity	0.01	0.07	.836	-0.12 to 0.14
R^2	.511			
Model 2 – Covariates				
High P.E.	0.23*	0.09	.013	0.05 to 0.41
No P.E.	0.35***	0.09	.000	0.16 to 0.53

Note. Values are expressed as coefficient. In Model 1, No P.E. is excluded as the comparison variable. In Model 2, Moderate P.E. is excluded as the comparison variable. Model 2 contained all covariates included in Model 1 but is condensed for table. 95% CI indicates confidence interval. *** = $p < .001$, ** = $p < .01$, * = $p < .05$, † = $p < .10$.

Table 9.

Linear regression predicting determinants of educational attainment during Wave 2.

Variable	*B*	*SE B*	*p* value	95% CI
Model 1				
High P.E.	-0.87***	0.12	.000	-1.11 to -0.63
Moderate P.E.	-0.97***	0.10	.000	-1.17 to -0.77
R^2	.110			
Model 2				
High P.E.	0.10	0.12	.414	-0.14 to 0.34
No P.E.	0.97***	0.10	.000	0.77 to 1.17
Model 1 – Covariates				
High P.E.	-0.03	0.04	.486	-0.10 to 0.05
Moderate P.E.	-0.06†	0.04	.080	-0.13 to 0.01
Age	0.34*	0.16	.031	0.03 to 0.65
Male	-0.09	0.06	.116	-0.20 to 0.02
Poverty Ratio	0.00†	0.00	.093	-0.00 to 0.01
Maternal Education	0.07*	0.03	.019	0.01 to 0.12
African American	0.02	0.03	.507	-0.04 to 0.08
American Indian	-0.02	0.06	.719	-0.15 to 0.10
Asian	0.21***	0.06	.000	0.10 to 0.32
Other	0.08	0.06	.185	-0.04 to 0.19
Hispanic	-0.02	0.05	.716	-0.12 to 0.08
High Total Activity	0.01	0.03	.674	-0.05 to 0.07
GPA (w.1)	-0.01	0.01	.669	-0.03 to 0.02
Educational Attainment	-0.60**	0.19	.002	0.22 to 0.97
Attention (w.1)	0.00*	0.00	.046	0.00 to 0.00
PPVT (w.1)	0.00*	0.00	.027	0.00 to 0.00
BMI (w.1)	0.00	0.00	.148	-0.00 to 0.01
R^2	.914			
Model 2 – Covariates				
High P.E.	0.04	0.03	.267	-0.03 to 0.10
No P.E.	0.06†	0.04	.080	0.03 to 0.65

Note. Values are expressed as coefficient. In Model 1, No P.E. is excluded as the comparison variable. Model 2 was not reported due to no significance. Model 2 contained all covariates included in Model 1 but is condensed for table. (w.1) indicates variables from Wave 1. 95% CI indicates confidence interval. *** = $p < .001$, ** = $p < .01$, * = $p < .05$, † = $p < .10$.

Table 10.

Linear regression predicting determinants of educational attainment during Wave 3.

Variable	*B*	*SE B*	*p* value	95% CI
Model 1				
High P.E. (w.2)	-0.32†	0.17	.066	-0.66 to 0.02
Moderate P.E. (w.2)	-0.13	0.17	.431	-0.47 to 0.20
R^2	.004			
Model 2				
High P.E. (w.2)	-0.19	0.19	.313	-0.55 to 0.18
No P.E. (w.2)	0.13	0.17	.431	-0.20 to 0.47
Model 1 – Covariates				
High P.E. (w.2)	0.22	0.16	.169	-0.09 to 0.53
Moderate P.E. (w.2)	0.42*	0.16	.011	0.10 to 0.74
Age	0.16*	0.07	.023	0.02 to 0.31
Male	-0.45***	0.12	.000	-0.69 to -0.21
Poverty Ratio	0.01	0.03	.719	-0.05 to 0.07
Maternal Education	0.66***	0.13	.000	0.41 to 0.91
African American	-0.24	0.19	.207	-0.62 to 0.13
American Indian	-0.26	0.34	.445	-0.92 to 0.40
Asian	0.67†	0.36	.065	-0.04 to 1.37
Other	0.09	0.25	.733	-0.41 to 0.59
Hispanic	-0.36	0.25	.146	-0.85 to 0.13
High Total Activity	-0.03	0.12	.777	-0.28 to 0.21
GPA (w.1)	0.21***	0.05	.000	0.12 to 0.31
Educational Attainment	0.24**	0.08	.003	0.08 to 0.40
Attention (w.1)	-0.00	0.00	.688	-0.00 to 0.00
PPVT (w.1)	0.01***	0.00	.000	0.00 to 0.01
BMI (w.1)	-0.01	0.01	.264	-0.03 to 0.01
R^2	.283			
Model 2 – Covariates				
High P.E. (w.2)	-0.20	0.15	.201	-0.50 to 0.11
No P.E. (w.2)	-0.42*	0.16	.011	-0.74 to -0.10

Note. Values are expressed as coefficient. In Model 1, No P.E. is excluded as the comparison variable. In Model 2, Moderate P.E. is excluded as the comparison variable. Model 2 contained all covariates included in Model 1 but is condensed for table. (w.1) indicates variables from Wave 1. (w.2) indicates variables from Wave 2. 95% CI indicates confidence interval.
*** = $p < .001$, ** = $p < .01$, * = $p < .05$, † = $p < .10$.

Table 11.

Linear regression predicting determinants of educational attainment during Wave 3.

Variable	*B*	*SE B*	*p* value	95% CI
Model 1				
Average High P.E.	-0.59**	0.20	.003	-0.99 to -0.20
Average Moderate P.E.	-0.44*	0.21	.038	-0.85 to -0.02
R^2	.011			
Model 2				
Average High P.E.	-0.16	0.22	.484	-0.59 to 0.28
Average No P.E.	0.44*	0.21	.038	0.02 to 0.85
Model 1 – Covariates				
Average High P.E.	0.01	0.19	.976	-0.37 to 0.39
Average Moderate P.E.	0.13	0.21	.555	-0.29 to 0.55
Age	0.29***	0.05	.000	0.19 to 0.39
Male	-0.54***	0.13	.000	-0.79 to -0.28
Poverty Ratio	0.03	0.04	.385	-0.04 to 0.11
Maternal Education	0.91***	0.14	.000	0.63 to 1.20
African American	-0.47**	0.18	.009	-0.82 to -0.12
American Indian	-0.28	0.32	.387	-0.91 to 0.35
Asian	0.15	0.30	.625	-0.44 to 0.73
Other	0.13	0.27	.627	-0.41 to 0.67
Hispanic	-0.59*	0.28	.036	-1.14 to -0.04
High Total Activity	0.01	0.13	.928	-0.24 to 0.26
R^2	.166			
Model 2 – Covariates				
Average High P.E.	-0.12	0.19	.533	-0.50 to 0.26
Average No P.E.	-0.13	-.21	.555	-0.55 to 0.29

Note. Values are expressed as coefficient. In Model 1, Average No P.E. is excluded as the comparison variable. In Model 2, Average Moderate P.E. is excluded as the comparison variable. Model 2 contained all covariates included in Model 1 but is condensed for table. 95% CI indicates confidence interval. *** = $p < .001$, ** = $p < .01$, * = $p < .05$.

Table 12.

Linear regression predicting determinants of cognitive performance (PPVT score) during Wave 1.

Variable	*B*	*SE B*	*p* value	95% CI
Model 1				
High P.E.	-17.63***	5.00	.000	-27.43 to -7.82
Moderate P.E.	-14.62**	4.82	.002	-24.07 to -5.17
R^2	.012			
Model 2				
High P.E.	-3.00	5.07	.554	-12.95 to 6.95
No P.E.	14.62**	4.82	.002	5.17 to 24.07
Model 1 – Covariates				
High P.E.	-6.97	4.94	.159	-16.66 to 2.72
Moderate P.E.	-7.57	4.96	.128	-17.30 to 2.17
Age	5.89***	1.54	.000	2.88 to 8.90
Male	7.67*	3.84	.046	0.14 to 15.19
Poverty Ratio	2.40**	0.79	.003	0.85 to 3.96
Maternal Education	26.14***	3.99	.000	18.32 to 33.96
African American	-44.67***	4.90	.000	-54.28 to -35.07
American Indian	6.67	7.48	.373	-8.01 to 21.35
Asian	-38.96**	13.05	.003	-64.56 to -13.37
Other	-2.88	8.77	.742	-20.08 to 14.31
Hispanic	-25.64**	7.53	.001	-40.41 to -10.87
High Total Activity	4.71	3.73	.206	-2.60 to 12.02
R^2	.176			
Model 2 – Covariates				
High P.E.	0.59	4.58	.897	-8.39 to 9.58
No P.E.	7.57	4.96	.128	-2.17 to 17.30

Note. Values are expressed as coefficient. In Model 1, No P.E. is excluded as the comparison variable. In Model 2, Moderate P.E. is excluded as the comparison variable. Model 2 contained all covariates included in Model 1 but is condensed for table. 95% CI indicates confidence interval. *** = $p < .001$, ** = $p < .01$, * = $p < .05$.

Table 13.

Linear regression predicting determinants of cognitive performance (PPVT score) during Wave 3.

Variable	*B*	*SE B*	*p* value	95% CI
Model 1				
High P.E. (w.2)	-0.19	0.19	.313	-0.55 to 0.18
Moderate P.E. (w.2)	0.13	0.17	.431	-0.20 to 0.47
R^2	.004			
Model 2				
High P.E. (w.2)	-3.39	8.99	.707	-21.03 to 14.26
No P.E. (w.2)	-0.12	7.28	.987	-14.40 to 14.17
Model 1 – Covariates				
High P.E. (w.2)	-3.99	9.60	.678	-22.84 to 14.86
Moderate P.E. (w.2)	1.30	6.37	.839	-11.21 to 13.80
Age	7.61	6.28	.226	-4.72 to 19.93
Male	5.35	5.86	.361	-6.15 to 16.85
Poverty Ratio	-0.21	0.60	.726	-1.38 to 0.96
Maternal Education	14.96*	7.13	.036	0.96 to 28.96
African American	-5.09	8.88	.566	-22.52 to 12.33
American Indian	-15.72**	4.89	.001	-25.32 to -6.12
Asian	14.47	21.95	.510	-28.62 to 57.56
Other	15.76	10.77	.144	-5.38 to 36.89
Hispanic	-11.94*	5.88	.043	-23.48 to -0.40
High Total Activity	-13.43*	5.55	.016	-24.32 to -2.55
GPA (w.1)	-7.84*	3.49	.025	-14.69 to -0.98
Educational attainment	-9.22	7.77	.236	-24.46 to 6.03
Attention (w.1)	0.00	0.05	.987	-0.10 to 0.11
PPVT (w.1)	-0.05	0.09	.583	-0.23 to 0.13
BMI (w.1)	0.69	0.50	.164	-0.28 to 1.67
R^2	.073			
Model 2 – Covariates				
High P.E. (w.2)	-5.29	9.32	.570	-23.58 to 13.00
No P.E. (w.2)	-1.30	6.37	.839	-13.80 to 11.21

Note. Values are expressed as coefficient. In Model 1, No P.E. is excluded as the comparison variable. In Model 2, Moderate P.E. is excluded as the comparison variable. Model 2 contained all covariates included in Model 1 but is condensed for table. (w.1) indicates variables from Wave 1. (w.2) indicates variables from Wave 2. 95% CI indicates confidence interval.
** = $p < .01$, * = $p < .05$.

Table 14.

Linear regression predicting determinants of cognitive performance (PPVT score) during Wave 3.

Variable	*B*	*SE B*	*p* value	95% CI
Model 1				
Average High P.E.	-12.22	9.04	.177	-29.96 to 5.53
Average Moderate P.E.	1.78	9.80	.856	-17.45 to 21.02
R^2	.004			
Model 2				
Average High P.E.	-14.00	11.24	.213	-36.06 to 8.06
Average No P.E.	-1.78	9.81	.856	-21.02 to 17.45
Model 1 – Covariates				
Average High P.E.	-11.08	10.00	.268	-30.71 to 8.55
Average Moderate P.E.	5.14	9.67	.595	-13.83 to 24.11
Age	3.14	2.27	.167	-1.31 to 7.60
Male	7.70	6.58	.242	-2.17 to 0.62
Poverty Ratio	-0.78	0.71	.274	-2.17 to 0.62
Maternal Education	7.29	6.58	.242	-5.21 to 20.62
African American	-1.10	7.25	.879	-15.33 to 13.12
American Indian	-14.10***	3.99	.000	-21.92 to -6.27
Asian	25.72	34.59	.457	-42.17 to 93.61
Other	13.05	10.28	.205	-7.13 to 33.23
Hispanic	-8.51†	4.40	.053	-17.15 to 0.13
High Total Activity	-13.00*	5.77	.025	-24.32 to -1.67
R^2	.028			
Model 2 – Covariates				
Average High P.E.	-16.22	11.47	.158	-38.74 to 6.30
Average No P.E.	-5.14	9.67	.595	-24.11 to 13.83

Note. Values are expressed as coefficient. In Model 1, Average No P.E. is excluded as the comparison variable. In Model 2, Average Moderate P.E. is excluded as the comparison variable. Model 2 contained all covariates included in Model 1 but is condensed for table. 95% CI indicates confidence interval. *** = $p < .001$, * = $p < .05$, † = $p < .10$.

Table 15.

Linear regression predicting determinants of health status (BMI) during Wave 1.

Variable	*B*	*SE B*	*p* value	95% CI
Model 1				
High P.E.	-0.53	0.43	.223	-1.37 to 0.32
Moderate P.E.	-0.79*	0.37	.031	-1.52 to -0.07
R^2	.003			
Model 2				
High P.E.	0.27	0.43	.533	-0.58 to 1.11
No P.E.	0.79*	0.37	.031	0.07 to 1.52
Model 1 – Covariates				
High P.E.	-0.20	0.45	.661	-1.07 to 0.68
Moderate P.E.	-0.34	0.40	.389	-1.12 to 0.43
Age	0.48***	0.12	.000	0.25 to 0.72
Male	0.89**	0.33	.006	0.25 to 1.53
Poverty Ratio	-0.01	0.04	.882	-0.07 to 0.06
Maternal Education	-0.42	0.33	.193	-1.06 to 0.21
African American	0.91*	0.42	.028	0.10 to 1.72
American Indian	2.37†	1.30	.067	-0.17 to 4.92
Asian	-1.25*	0.58	.032	-2.39 to -0.11
Other	-1.05	0.92	.251	-2.85 to 0.75
Hispanic	-0.38	0.76	.622	-1.88 to 1.12
High Total Activity	0.14	0.32	.664	-0.49 to 0.76
R^2	.043			
Model 2 – Covariates				
High P.E.	0.14	0.42	.732	-0.68 to 0.97
No P.E.	0.34	0.40	.389	-0.43 to 1.12

Note. Values are expressed as coefficient. In Model 1, No P.E. is excluded as the comparison variable. In Model 2, Moderate P.E. is excluded as the comparison variable. Model 2 contained all covariates included in Model 1 but is condensed for table. 95% CI indicates confidence interval. *** = $p < .001$, ** = $p < .01$, * = $p < .05$, † = $p < .10$.

Table 16.

Linear regression predicting determinants of health status (BMI) during Wave 2.

Variable	*B*	*SE B*	*p* value	95% CI
Model 1				
High P.E.	-0.37	0.59	.526	-1.52 to 0.78
Moderate P.E.	-0.85*	0.36	.018	-1.55 to -0.15
R^2	.006			
Model 2				
High P.E.	0.48	0.59	.420	-0.69 to 1.64
No P.E.	0.85*	0.36	.018	0.15 to 1.55
Model 1 – Covariates				
High P.E.	-0.17	0.40	.666	-0.95 to 0.61
Moderate P.E.	-0.20	0.30	.503	-0.80 to 0.39
Age	0.42†	0.24	.082	-0.05 to 0.88
Male	0.30	0.28	.284	-0.25 to 0.86
Poverty Ratio	-0.02	0.03	.385	-0.07 to 0.03
Maternal Education	-0.47†	0.27	.083	-1.01 to 0.06
African American	0.32	0.37	.388	-0.40 to 1.04
American Indian	1.25	1.05	.232	-0.80 to 3.31
Asian	-0.41	0.47	.388	-1.33 to 0.52
Other	0.21	0.72	.774	-1.21 to 1.63
Hispanic	-0.43	0.58	.462	-1.58 to 0.72
High Total Activity	-0.23	0.26	.384	-0.74 to 0.28
GPA (w.1)	-0.08	0.11	.464	-0.28 to 0.13
Educational attainment	-0.54*	0.26	.039	-1.04 to -0.03
Attention (w.1)	-0.00	0.00	.538	-0.01 to 0.00
PPVT (w.1)	0.00	0.00	.839	-0.00 to 0.00
BMI (w.1)	0.52***	0.06	.000	0.39 to 0.65
R^2	.402			
Model 2 – Covariates				
High P.E.	0.03	0.41	.939	-0.78 to 0.84
No P.E.	0.20	0.30	.503	-0.39 to 0.80

Note. Values are expressed as coefficient. In Model 1, No P.E. is excluded as the comparison variable. In Model 2, Moderate P.E. is excluded as the comparison variable. Model 2 contained all covariates included in Model 1 but is condensed for table. (w.1) indicates variables from Wave 1. 95% CI indicates confidence interval. *** = $p < .001$, * = $p < .05$, † = $p < .10$.

Table 17.

Linear regression predicting determinants of health status (BMI) during Wave 3.

Variable	*B*	*SE B*	*p* value	95% CI
Model 1				
High P.E. (w.2)	-0.86	0.59	.147	-2.02 to 0.30
Moderate P.E. (w.2)	-1.17*	0.48	.014	-2.11 to -0.24
R^2	.009			
Model 2				
High P.E. (w.2)	0.31	0.59	.596	-0.84 to 1.47
No P.E. (w.2)	1.17*	0.48	.014	0.24 to 2.11
Model 1 – Covariates				
High P.E. (w.2)	-0.75	0.55	.170	-1.83 to 0.32
Moderate P.E. (w.2)	-0.82†	0.47	.081	-1.74 to 0.10
Age	0.02	0.36	.960	-0.70 to 0.73
Male	0.52	0.40	.198	-0.27 to 1.32
Poverty Ratio	0.00	0.04	.986	-0.07 to 0.07
Maternal Education	-0.88*	0.37	.019	-1.62 to -0.15
African American	0.68	0.50	.174	-0.30 to 1.67
American Indian	-0.97	0.97	.317	-2.88 to 0.93
Asian	-0.79	1.07	.458	-2.89 to 1.30
Other	-0.45	0.69	.518	-1.81 to 0.91
Hispanic	0.08	0.67	.906	-1.24 to 1.39
High Total Activity	-0.33	0.38	.390	-1.08 to 0.42
GPA (w.1)	-0.31†	0.17	.063	-0.64 to 0.02
Educational Attainment	-0.32	0.38	.398	-1.05 to 0.42
Attention (w.1)	-0.00	0.00	.852	-0.01 to 0.00
PPVT (w.1)	-0.00	0.00	.606	-0.01 to 0.00
BMI (w.1)	0.50***	0.76	.000	0.35 to 0.65
R^2	.286			
Model 2 – Covariates				
High P.E. (w.2)	0.06	0.50	.898	-0.91 to 1.04
No P.E. (w.2)	0.82†	0.47	.081	-0.10 to 1.74

Note. Values are expressed as coefficient. In Model 1, No P.E. is excluded as the comparison variable. In Model 2, Moderate P.E. is excluded as the comparison variable. Model 2 contained all covariates included in Model 1 but is condensed for table. (w.1) indicates variables from Wave 1. (w.2) indicates variables from Wave 2. 95% CI indicates confidence interval.
*** = $p < .001$, * = $p < .05$, † = $p < .10$.

Table 18.

Linear regression predicting determinants of health status (BMI) during Wave 3.

Variable	*B*	*SE B*	*p* value	95% CI
Model 1				
Average High P.E.	-0.82	0.70	.244	-2.19 to 0.56
Average Moderate P.E.	-1.25*	0.63	.046	-2.48 to -0.02
R^2	.006			
Model 2				
Average High P.E.	0.43	0.71	.542	-0.96 to 1.83
Average No P.E.	1.25*	0.63	.046	0.02 to 2.48
Model 1 – Covariates				
Average High P.E.	-1.06	0.72	.137	-2.47 to 0.34
Average Moderate P.E.	-1.35*	0.68	.046	-2.68 to -0.02
Age	0.07	0.16	.676	-0.24 to 0.38
Male	0.84†	0.43	.050	-0.00 to 1.68
Poverty Ratio	-0.03	0.06	.569	-0.15 to 0.08
Maternal Education	-1.16**	0.43	.007	-2.00 to -0.32
African American	1.39*	0.60	.021	0.21 to 2.58
American Indian	-0.74	0.86	.386	-2.42 to 0.89
Hispanic	0.33	0.88	.705	-1.40 to 2.07
High Total Activity	-0.13	0.44	.765	-1.00 to 0.73
R^2	.033			
Model 2 – Covariates				
Average High P.E.	0.29	0.70	.683	-1.09 to 1.66
Average No P.E.	1.35*	0.68	.046	0.02 to 2.68

Note. Values are expressed as coefficient. In Model 1, No P.E. is excluded as the comparison variable. In Model 2, Moderate P.E. is excluded as the comparison variable. Model 2 contained all covariates included in Model 1 but is condensed for table. 95% CI indicates confidence interval. ** = $p < .01$, * = $p < .05$, † = $p < .10$.

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