Abstract

In this study, we examined the relative influence of physical and psychosocial variables on math and reading achievement test scores. Between one and five months prior to taking annual standardized reading and math tests, 1211 6th through 8th graders (53.7% girls; 57.2% White) self-reported levels of physical activity, academic self-concept, self-esteem, and social support and participated in objective testing to obtain measures of body composition (BMI) and cardiorespiratory fitness. Socio-economic status (SES) and reading and math test scores were provided by the school district at the end of the school year. Regression analyses revealed that, after controlling for SES and academic self-concept, only cardiorespiratory fitness was a consistent predictor of the students’ performance in reading and math; perceived social support from family and friends was related to improvements in the boys’ reading scores. Our findings support schools re-examining policies that have limited students’ involvement in physical education classes.

KEYWORDS: Academic performance, physical fitness, social support, self-esteem, middle school students
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Physical and Psychological Predictors of Academic Performance
For Middle School Boys and Girls: A Longitudinal Investigation

Academic achievement, particularly among middle school students, is multiply determined, being influenced not only by school-related variables, such as academic self-concept (Green, Nelson, Martin, & Marsh, 2006; Osborne & Jones, 2011; Pintrich & De Groot, 1990; Stringer & Heath, 2011), but by physical and psychosocial factors as well (e.g., Ahmed, Minnaert, van der Werf, & Kuyper, 2010; Edwards, Mauch, & Winkelman, 2011; Kristjansson, Sigfusdottir, & Allegrante, 2010; Rapport, Denney, Chung, & Hustace, 2001; Roberts, Freed, & McCarthy, 2010). For example, better academic performances, measured through achievement test scores and grades, have been related to higher levels of cardiorespiratory fitness and/or physical activity (e.g., Castelli, Hillman, Buck, & Erwin, 2007; Chomitz et al., 2009; Eveland-Sayers, Farley, Fuller, Morgan, & Caputo, 2009; Singh Uijtdewilligen, Twisk, Mechelen, & Chinapaw, 2012), lower body mass index (e.g., Cottrell, Northrup, & Wittberg, 2007; Roberts et al., 2010; Welk, Jackson, Morrow, Haskell, Meredith, & Cooper, 2010), more social support (e.g., Ahmed et al., 2010; Edwards et al., 2010; Rosenfeld, Richman & Bowen, 2000), and greater self-esteem and less depression (e.g., Lundy, Silva, Kaemingk, Goodwin, & Quan, 2010; Rapport et al., 2001). Research, however, has been limited in three important ways. First, many studies have been cross-sectional (or retrospective) in design. Second, few studies have examined simultaneously physical (e.g., body composition, cardiorespiratory fitness) and psychosocial (e.g., self-esteem) variables to determine their relative importance in predicting students’ academic performance. Third, although some studies have included for important demographic variables (e.g., SES; Cottrell et al., 2007; Roberts et al., 2010), most have not controlled for the effects of prior academic readiness. Thus, in the current study, we utilize a
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prospective design to examine the potential influence of variables across multiple domains, while controlling for the effects of relevant demographic (i.e., sex, SES) and academic factors.

**Academic Self-Concept**

Academic self-concept, which is defined as students’ perception of their proficiency (and confidence) in general and/or specific academic areas, has been related positively to academic performance (Green et al., 2006; Osborne & Jones, 2011; Pintrich & De Groot, 1990; Stringer & Heath, 2008). For example, Pintrich and De Groot (1990) found, in a cross-sectional study of male and female 7th graders, that academic self-efficacy (as defined by feelings of competence and confidence in class work) was related to better performances on homework, quizzes/exams, essays/reports, and overall course grades. In a longitudinal study, 4th and 5th grade boys’ and girls’ academic self-perceptions of competence in both reading and mathematics, respectively, were significant predictors of their scores on standardized reading and math tests one year later (Stringer & Heath, 2008). Students with high levels of confidence in their academic abilities may be more motivated to study (and put forth more effort doing so), set more challenging academic goals, use more effective studying and test-taking strategies, and perform even better on subsequent academic tasks. Thus, to determine accurately the extent to which physical and psychosocial variables explain students’ academic performances, they need to control for either prior academic achievement or, if not available, students’ current academic self-concept.

**Body Composition**

Body composition generally is represented by individuals’ body mass index (BMI), a proportional measure of weight taking into account height. Studies examining its relationship to academic performance have been equivocal, demonstrating either no association (e.g., Edwards et al., 2011) or small effects (Cottrell et al., 2007; Kristjansson et al., 2010; Roberts et al., 2010;
Welk et al., 2010). Other researchers have reported zero-order, inverse relationships between overweight status (as measured by BMI) and state-mandated achievement test scores in reading and math, but also noted that these negative effects were attenuated when considered in conjunction with cardiorespiratory fitness (Cottrell et al., 2007; Roberts et al., 2010). These findings indicate that it is fitness levels, not obesity per se, which may be the primary influence on children’s achievement. Cottrell et al. (2007) suggested that future research incorporate a longitudinal design and examine not only body composition and fitness levels, but also social, emotional, and environmental factors so as to understand their relative importance.

Physical Activity and Physical Fitness

Being physically active and fit has been associated with improved academic performances in grades and test scores (Chomitz et al., 2009; Dwyer et al., 2001; Edwards et al., 2011; Fox, Barr-Anderson, Neumark-Sztainer & Wall, 2010; Kristjansson et al., 2010; Roberts et al., 2010). For example, Hillman et al. (2009) found, in an experimental study of male and female preadolescent children, that a single 20-minute bout of treadmill walking led to improved response accuracy in an incongruent visual stimuli task as well as higher scores on a standardized test of reading comprehension. In a sample of male and female middle and high school students, Fox et al. (2010) discovered that more time spent being physically active (mild, moderate, or vigorous levels) was associated with higher grade point averages, across gender and year in school. Singh et al. (2012), in their systematic review of the literature, concluded that there was strong evidence to link physical activity to higher levels of academic performance. Researchers also have identified several potential causal mechanisms linking physical activity to improvements in academic performance, including increased blood flow to the brain, neural activity (e.g., P3 amplitude), and response accuracy, increase cognitive controls (e.g., attentional
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focus), and improved memory function (Aberg et al., 2009; Chaddock, Pontifex, Hillman, & Kramer, 2011; Chomitz et al., 2009; Hillman et al., 2007; Pontifex et al., 2011).

Given the connection between physical activity and cardiorespiratory fitness, it is not surprising that fitness levels also have been related to academic performance (e.g., Aberg et al., 2009; Cottrell et al., 2007; Edwards et al., 2011; Wittberg, Cottrell, Davis, & Northrup, 2010; Roberts et al., 2010). For example, in a cross-sectional study of 5th, 7th, and 9th grade boys and girls, students whose one-mile run/walk times exceeded FITNESSGRAM® (The Cooper Institute, 2007) standards performed significantly worse on state reading, math, and language tests than those whose times met standards (Roberts et al., 2010). Using data supplied by the California Department of Education, Grissom (2005) found that as male and female 5th, 7th, and 9th graders’ overall performance on the FITNESSGRAM tests improved, so did their scores on state achievement tests in reading and mathematics. Among 5th grade boys and girls, overall fitness level, as determined through FITNESSGRAM testing, was related positively to state-achievement test scores in social studies, reading, math, and science, even after controlling for SES and body composition (Cottrell et al., 2007). Although physical activity and physical fitness have been associated independently with better academic performances, these factors have not been examined extensively in relation to other potential predictors to determine their relative influence.

Social Support and Self-Esteem

Although different psychosocial factors have been examined as potential predictors of academic performance, social support and self-esteem have received considerable support (Ahmed et al., 2008; Edwards et al., 2011; Rosenfeld et al., 2000). Social support has been conceptualized as the degree to which individuals are satisfied with the different types of support
they receive, such as problem-solving and emotional assistance, and how much they can rely on different people in their lives, such as from family and friends, for such support (Zimet, Dahlem, Zimet, & Farley, 1988). Middle and high school students with stronger perceptions of social support from peers, parents, and teachers not only earned better grades in their classes, but also had better attendance, higher levels of engagement in classes, and higher levels of satisfaction with their school experience (Rosenfeld et al., 2000). Social support is likely to help students be more confident in themselves and their abilities and have more control in challenging academic situations, which in turn can make their attitude more positive, their motivation stronger, and their academic performance better (Ahmed et al., 2008; Rosenfeld et al., 2000).

Self-esteem has been conceptualized as representing the extent to which individuals view themselves as effective and capable, and are satisfied with and proud of themselves as they currently are (Marsh, 1992). In a nationally-based, cross-sectional sample of male and female adolescents, self-esteem was related to higher self-reported grades in core subject areas (Kristjansson et al., 2008). Self-esteem is associated with lower levels of anxiety and depression, as well as higher levels of optimism, all of which may help students pay better attention in classes and be more motivated toward their studies (Lundy et al., 2010; Rapport et al., 2001). Students who feel positively about themselves and their lives and believe they generally are capable and effective may bring the necessary cognitive processing skills and maintain the needed attentional focus and effort to improve their academic performances. However, the influence of social support and self-esteem on academic performance, relative to other factors, such as cardiorespiratory fitness, needs further study (Cottrell et al., 2007).

The Current Study
Using a longitudinal design, our purpose was to examine the relative influences of body composition, cardiorespiratory fitness, physical activity, self-esteem, and social support on middle school students’ achievement on state administered reading and mathematics examinations. Given the strong relationships that exist between academic performance and socio-economic status (Cottrell et al., 2007) and academic self-concept (e.g., Green et al., 2006), we included these two variables to control for their effects. In doing so, we could determine the extent to which the physical and psychosocial variables influenced academic performance above and beyond that explained by the students’ belief in their academic abilities and the opportunities (e.g., financial, educational) that may have been afforded to them by coming from a more affluent family. Also, because there is evidence that the relationships between these variables and academic achievement are different for boys and girls (e.g., Eveland-Sayers et al., 2009; Grissom, 2005), we conducted the analyses separately for the male and female students to examine this possibility. We hypothesized that, after controlling for SES and academic self-concept, cardiorespiratory fitness, social support, and self-esteem would be positive predictors in each area of academic achievement. We expected that any bivariate relationships of physical activity levels and body composition to achievement test scores would be attenuated in the multivariate model.

Method

Participants

Participants were 1211 middle school students (650 girls) who were drawn from the five middle schools in a suburban school district in Texas. The boy’s mean age was 12.45 years ($SD = 1.00$); 38.1% were in 6th grade, 37.4% in 7th grade, and 24.4% in 8th grade. In terms of race/ethnicity, 57.2% were Caucasian, 24.2% were Mexican-American, 9.1% were African-
American, 1.1% were Asian, and 1.2% were American Indian. Consistent with past research (Cottrell et al., 2007), SES was based on federal guidelines for determining students’ status for free or reduced lunch based on family income: 24.1% received free lunch, 6.2% received reduced lunch, and 69.7% did not receive any reduction on their meals. Mean Body Mass Index (BMI) was 21.58 kg/m$^2$ ($SD = 7.92$).

Mean age for the girls was 12.29 years ($SD = 0.92$); 37.8% were in 6th grade, 35.5% in 7th grade, and 26.6% in 8th grade. Regarding race/ethnicity, 58.6% were Caucasian, 23.4% were Mexican-American, 9.2% were African-American, 2.3% were Asian, and 0.6% were American Indian. In terms of SES, 24.6% received free lunch, 4.6% received reduced lunch, and 70.8% did not receive any reduction on their meals. Mean BMI was 21.01 kg/m$^2$ ($SD = 4.71$).

**Measures**

*Demographic information.* The school district provided information on the students’ race/ethnicity, age, grade level, and whether or not they qualified for free or reduced lunch (which served as our proxy measure of SES).

*Academic achievement.* The school district provided the students’ scores on the state’s standardized reading and mathematics examinations (i.e., The Texas Assessment of Knowledge and Skills [TAKS]). Each school district in the state administers these examinations on the same dates (for grade and exam) during the month of April each academic school year. Examinations are scored at the state-level and then reported to each district.

*Academic self-concept.* Three single items from the Self-Description Questionnaire II (SDQII; Marsh 1992) measure general and specific aspects of academic self-concept, including “I am good at mathematics,” “I like reading,” and “I am good at most school subjects.” Participants rate each item on a 6-point scale that ranges from 1, *false*, to 6, *true*. Marsh (1992)
has provided extensive information regarding the validity of the items as measures of academic self-concept.

*Cardiorespiratory fitness and body composition.* The FITNESSGRAM (The Cooper Institute, 2007) provides an objective measure of cardiorespiratory fitness through the PACER (Progressive Aerobic Cardiovascular Endurance Run) test and body composition through the students’ body mass index (BMI), which is represented in kg/m². Administered by trained professionals, the PACER is represented by the number of 20-meter laps students complete within a specified timeframe and pace. Weight was measured by the researchers (in conjunction with the physical education teachers at each school) using a Seca digital scale (Model 882) and recorded to the nearest .1 lb; scales were recalibrated at the beginning of each testing day. Height and weight was transformed into BMI within the FITNESSGRAM program. The FITNESSGRAM/ACTIVITY manual (The Cooper Institute, 2007) provides extensive information about the validity and reliability of the PACER and BMI as measures of cardiorespiratory fitness and body composition, respectively.

*Physical activity.* The FITNESSGRAM (The Cooper Institute, 2007) provides three self-report questions to assess how often individuals participated in activities that were focused on improving aerobic fitness, strength, and flexibility. Each item is rated in terms of the number of days, out of the last seven, they engaged in the described physical activities (e.g., for aerobic fitness, a timeframe of 30 to 60 minutes or more per day is specified). Thus, scores range from 0 to 7; higher numbers indicate more days (during the last week) that the individual engaged in that type of physical activity at the required level. The FITNESSGRAM/ACTIVITY manual (see The Cooper Institute, 2007) provides extensive information about these questions as reliable and valid representations of physical activity.
**Self-esteem.** The 10-item general self-esteem scale from the Self-Description Questionnaire II (SDQII-GSE; Marsh 1992) measures how proud and satisfied adolescents are with themselves. On items such as “Overall, I have a lot to be proud of,” participants respond using a 6-point scale that ranges from 1, false, to 6, true. Total score is the mean; higher scores represent greater esteem. Marsh, Ellis, Parada, Richards, and Heubeck (2005) reported Cronbach’s alphas that ranged from .80 to .89 in a sample of male and female adolescents; Cronbach’s alpha for the current sample was .88. Marsh and colleagues (1992; Marsh et al., 2005) have provided extensive information regarding the scale’s validity.

**Social support.** Eight items from the Multidimensional Scale of Perceived Social Support (MSPSS; Zimet et al., 1988) were used to measure how much help and support participants believe they receive from friends and family. On items such as “My family helps me make decisions,” participants respond using a 7-point scale that ranges from 1, very strongly disagree, to 7, very strongly agree. Total score is the mean; higher scores represent more perceived social support from friends and family. Zimet et al. (1988) reported a Cronbach’s alpha of .88 and a two to three month test-retest reliability of .85 in a sample of male and female undergraduates; Cronbach’s alpha for the current sample was .89. Zimet and colleagues (Zimet et al., 1988; Zimet, Powell, Farley, & Werkman, 1990) have provided extensive information regarding the scale’s validity.

**Procedure**

Approval for the study was received from the university’s IRB for Human Subjects Research as well as from the school district’s associate superintendent and the principals at each of the five middle schools. Prior to participating in the study, parental consent and child assent was obtained. At each school, the authors assisted PE instructors in the administration of the
FITNESSGRAM protocol to obtain the state-required, annual fitness testing results during the 2009–2010 academic year.

FITNESSGRAM testing occurred at each school during a one week period that was scheduled between November 2009 and March 2010; the testing dates were determined by the principal at each school (Time 1). During each week-long session, the children completed the PACER as well as had their height and weight measured. The students from whom consent and assent had been obtained also completed the questionnaires during their PE classes. Questionnaires took approximately 15 minutes to finish. To link questionnaire data to the results from their FITNESSGRAM tests and with data supplied by the district, participants put their student ID numbers (but no other identifying information) on their questionnaires. Following completion of the questionnaires, students were entered into a random drawing for a series of cash prizes that were given away at each school. Because the TAKS is a state mandated and administered achievement test, all students across the five middle schools took the math and reading examinations on the same dates in April, 2010 (Time 2). Depending on when fitness testing was scheduled at each middle school, FITNESSGRAM and questionnaire data were collected one to five months prior to the students taking their TAKS examinations.

Data Analysis

First, we addressed the issue of missing data and found that only between 0% and 1.9% were missing across the questionnaire items. Because items were either missing completely at random or at random, we replaced the values using the expectation maximization procedure (Schlomer, Bauman, & Card, 2010). Second, we examined the distributional properties (e.g., skewness) of all the measures and found them to be within acceptable levels so no
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Transformations were made to the data. Next, we computed the zero-order correlations among all the variables separately by sex.

To determine the relative contribution of the different variables in predicting the boys’ and girls’ performance on their math and reading examinations, we used hierarchical multiple regression and conducted the analyses separately by sex. For each regression model, there were five steps. At Step 1, we entered the families’ SES level to control for influences of social affluence, prosperity, and education (Cottrell et al., 2007; Edwards et al., 2011; Roberts et al., 2010). At Step 2, we entered the reading or math self-concept score (matched to the achievement test being used as the criterion variable) as well as the overall academic self-concept item. We entered these variables at this step to control for influences related to students’ perceptions of their academic abilities (e.g., Green et al., 2006). At Step 3, we entered the number of PACER laps, which represented the student’s level of cardiorespiratory fitness, and their BMI (i.e., body composition). At Step 4, we entered the three variables for physical activity – aerobic, strength, and flexibility. Finally, at Step 5, we entered the students’ general self-esteem and perceived social support.

Results

Descriptive Statistics

Correlations, means and standard deviations for both the predictor and criterion variables are presented by sex in Table 1. The highest correlation among the predictor variables was .56, which suggests that multi-collinearity would not be an issue during the regression analyses.

With the exception of BMI (which was related only to reading test scores), aerobic physical activity level (which was related only for boys), and flexibility physical activity level (which was related only for girls), the bivariate relationships between the predictor variables and
each measure of academic achievement were significant and in the expected direction. For example, greater self-esteem, more social support, and higher levels of cardiorespiratory fitness all were related to better performance on the math and reading tests for boys and girls.

Regression Analyses

Reading achievement. For the boys, the inclusion of SES at Step 1 was significant, accounting for 9.7% of the variance, \( \text{Adj. } R^2 = .095, F (1, 559) = 59.78, p < .0001 \). Step 2 of the model, in which we included the academic self-concept measures, was significant and accounted for an additional 5.2% of the variance, \( F (2, 557) = 17.17, p < .0001 \). At Step 3, entry of the PACER and BMI accounted for an additional 3.9% of the variance, \( F (2, 555) = 13.19, p < .0001 \). At Step 4, the inclusion of the physical activity measures was not significant, \( F (3, 552) = 1.17, p = .32, \Delta R^2 = .005 \). Finally, at Step 5, the addition of self-esteem and social support accounted for an additional 2.6% of the variance, \( F (2, 550) = 9.19, p < .0001 \). The overall model was significant, accounting for 21.9% (Adj. \( R^2 = .205 \)) of the variance in the boys’ reading scores, \( F (10, 550) = 15.41, p < .001 \). Within the full model, after controlling for household SES level and the boys’ general and reading-specific academic self-concept, only their cardiorespiratory fitness levels (i.e., PACER) and their perceived social support from family and friends predicted better performances on the TAKS reading exam. See Table 2 for the detailed statistics from Step 5 of the regression analysis.

For the girls, the inclusion of SES level was significant, accounting for 14.5% of the variance, \( \text{Adj. } R^2 = .143, F (1, 648) = 109.61, p < .0001 \). Step 2, which included entry of the academic self-concept measures, accounted for an additional 7.3% of the variance, \( F (2, 646) = 30.24, p < .0001 \). At Step 3, the girls’ cardiorespiratory fitness levels and body composition accounted for an additional 4.6% of the variance, \( F (2, 644) = 20.19, p < .0001 \). At Step 4, the
physical activity measures were not significant, accounting for less than 1% of the variance, $F(3, 641) = 1.78, p = .15$. Finally, at Step 5, the addition of the girls’ self-esteem and perceived social support was not significant, explaining only 0.2% of the variance, $F(2, 639) = 0.930, p = .40$. The overall model was significant, accounting for 27.2% of the variance (Adj. $R^2 = .261$) of the girls’ reading scores, $F(10, 639) = 23.91, p < .0001$. Within the full model, after controlling for the girls’ families’ SES and their academic self-concept, only their cardiorespiratory fitness and their body composition predicted their reading scores (see Table 2).

Math achievement. For the boys, the entry of SES level was significant, accounting for 8.0% of the variance, Adj. $R^2 = .080$, $F(1, 623) = 54.46, p < .0001$. Step 2, in which we entered the academic self-concept measures, was also significant, $F(2, 621) = 62.41, p < .0001, \Delta R^2 = .15$. At Step 3, the boys’ cardiorespiratory fitness levels and their body composition accounted for an additional 4.7% of the variance, $F(2, 619) = 20.11, p < .0001$. At Step 4, the inclusion of the physical activity measures was not significant, explaining less than 1% additional variance, $F(3, 616) = 2.40, p = .07$. Finally, at Step 5, the inclusion of the boys’ self-esteem and perceived social support also was not significant, $F(2, 614) = 1.26, p = .28, \Delta R^2 = .003$. The overall model was significant and accounted for 29.2% (Adj. $R^2 = .281$) of the variance of the boy’s mathematics scores, $F(10, 614) = 25.35, p < .0001$. After controlling for the boys’ families’ SES levels and their academic self-concept, only their level of cardiorespiratory fitness predicted how they performed on the math TAKS test (see Table 3).

For the girls, the inclusion of SES at Step 1 of the model was significant, accounting for 9.9% of the variance, Adj. $R^2 = .098$, $F(1, 648) = 71.50, p < .0001$. At Step 2, inclusion of the academic self-concept measures was also significant, $F(2, 646) = 73.42, p < .0001, \Delta R^2 = .17$. At Step 3, the girls’ cardiorespiratory fitness level and body composition were significant,
explaining an additional 2.3% of the variance, $F(2, 644) = 10.36, p < .0001$. At Step 4, the inclusion of the physical activity measures was not significant, $F(3, 641) = 2.65, p = .05, \Delta R^2 = .01$. Finally, at Step 5, self-esteem and perceived social support were not significant, $F(2, 639) = 0.42, p = .66$, accounting for less than 0.1% of the variance. The overall model was significant, accounting for 29.9% (Adj. $R^2 = .288$) of the variance of the girls’ mathematics scores, $F(10, 639) = 27.22, p < .0001$. After controlling for their families’ SES level and their academic self-concept, only the girls’ cardiorespiratory fitness explained their performance on the math TAKS test (see Table 3).

Discussion

Except for BMI, aerobic activity, and flexibility, the physical and psychological variables were related in the expected directions with the math and reading achievement scores. These variables shared between 2% and 20% of the variance across the two measures of academic achievement, supporting previous research that has demonstrated that physical activity levels, physical fitness, body composition, and various measures of psychosocial functioning (e.g., social support) are associated with better academic performances among children and adolescents (e.g., Cottrell et al., 2007; Edwards et al., 2011; Grissom, 2005; Hillman et al., 2009; Kristjansson et al., 2010; Roberts et al., 2010; Rosenfeld et al., 2000). However, when all the variables were considered within the regression analyses, only certain effects remained significant as expected. Because of our study’s longitudinal design, these variables can now be considered “risk factors” (Stice, 2002) in relation to middle school students’ performances on state-mandated math and reading examinations. The identification of specific risk factors is essential for the development of data-based, effective prevention programs.
Although there were two differences across sex (which we discuss in more detail below), findings were consistent in terms of which variables were risk factors and how much variance they explained in the achievement test scores. As expected, both SES, and the measures of academic achievement were significant predictors of the girls’ and boys’ performances. Those students who came from higher SES homes earned higher scores on the math and reading examinations, which is consistent with past research (Cottrell et al., 2007; Edwards et al., 2011). In addition, general and specific measures of academic self-concept were related to the students’ test scores, such that the boys and girls who either believed they were good in most of their school subjects, liked reading, or thought they were good at math actually performed better. Similarly, Stringer and Heath (2008) found that 4th and 5th grade boys’ and girls’ self-perceptions of their academic competence predicted their performance on standardized achievement tests taken one year later. Students who perform well on academic tasks, and attribute their success to internal factors, such as effort, are likely to see increases in their academic self-concept in general, but also specific to the area where they have experienced the success. Thus, providing students with the tools to be academically successful and helping them develop a belief in their abilities can have long-term positive effects on their academic performances.

The only variable to be related consistently to the students’ performance was their level of cardiorespiratory fitness. Consistent with past studies (e.g., Aberg et al., 2009; Cottrell et al., 2007; Edwards et al., 2011; Grissom, 2005; Roberts et al., 2010), the more fit the students’ were in terms of their cardiorespiratory functioning, the better they performed on both the math and reading examinations. This finding is noteworthy for three reasons. First, because of our longitudinal design, we can conclude that middle school boys’ and girls’ level of cardiorespiratory fitness influences how they perform on subsequent academic tests. Higher
levels of fitness also are associated with improvements in cognitive control, including inhibition (ability to selectively pay attention to relevant information) and working memory, as well as increases in response accuracy and more cognitive flexibility to handle task demands (e.g., Chaddock et al., 2011; Pontifex et al., 2011), which are suggested to explain the improvements in academic performances. Second, the relationship between fitness and academic performance existed even after we had controlled for the influences of the students’ family SES and their academic self-concept, variables that have been strongly related to achievement test scores (e.g., Cottrell et al., 2007). Third, although higher levels of physical activity (i.e., aerobic, strength, and flexibility) were associated with higher levels of cardiorespiratory fitness, particularly among the boys in our study, it was only the students’ fitness levels that predicted their academic performances. As the results from longitudinal studies, such as ours, continue to establish a temporal association between fitness and subsequent improvements in academic measures, researchers will want to continue to study the neurocognitive and physiological mechanisms that may underlie this relationship (Chaddock et al., 2011).

The relations between the physical and psychosocial variables and the two measures of academic achievement differed slightly for the boys and girls, which had been suggested by past research (e.g., Eveland-Sayers et al., 2009). For the reading exam, the variables accounted for more variance in the girls than the boys and were predictive for one but not the other. Specifically, for boys (but not for girls), higher levels of social support had a direct and positive influence on how they performed on the exam, which is consistent with Ahmed et al. (2010) who found parental and peer support were related directly to academic achievement. For girls, but not boys, having a larger BMI was related to better performances on the reading exam, which is both counterintuitive as well as inconsistent with the past research (e.g., Eveland-Sayers et al.,
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2009; Grissom, 2005; Kristjansson et al., 2010). However, like past studies (e.g., Cottrell et al., 2007) being overweight was not as important for understanding boys’ and girls’ performances on state-mandated achievement tests as was their level of physical fitness.

Limitations and Directions for Future Research

There are a few limitations to the present study. First, most of the psychosocial and physical variables used were self-report, though we did incorporate objective measures of cardiorespiratory fitness and body composition. Future studies might consider a more objective measure of physical activity, such as having students wear accelerometers for a one to two week period of time, to complement the manner in which physical fitness was assessed. It will be important for future studies to further examine the relationship between physical activity and fitness and their relative contributions (when both are measured objectively) to academic performance. Second, the sample was obtained from only one school district in the southern United States, thus limiting its generalizability to similar suburban areas. The sample, however, was diverse in terms of racial/ethnic and socio-economic status, and accurately represented the overall demographics of the students in the district. Future studies might examine the influence of such physical and psychosocial variables in urban or rural districts and among high school students. Third, not all relevant physical and psychosocial factors were included in the study. We did use variables that had been shown to relate to academic achievement, but time constraints placed on us by the district in terms of access to the students prevented us from including other potential predictors, such as anxiety, depression, nutritional status, to name a few. Future research may want to examine the relative predictive utility of these other factors, as well as variables such as student delinquency to determine their long-term effect on academic achievement. Finally, although our study used a longitudinal design, the timeframe between
when the physical and psychosocial variables were measured to when the students took the math and reading examinations was limited to one to five months. Future research should examine the long-term effects of fitness and other psychological variables, determining whether the effects uncovered in this study last from year to year across middle and high school.

Clinical Implications

Given the study’s design, our results support several potential interventions that may be implemented to boost middle school students’ achievement on state-based reading and math tests. First, as expected, lower SES level had a negative effect on the children’s test scores. Low SES students may experience difficulties, such as a lack of resources, little support or academic help from parents/guardians, and familial discord/stress, that can interfere with needed motivation, focus, and attention, and, overall, create an environment that is not conducive to or supportive of learning. Therefore, it becomes necessary to identify these children early in their school careers and provide as many extra services as possible, such as after school tutoring, individual and/or family counseling, after school care, summer meal programs, etc. By ameliorating the potential negative effects associated with low SES environments, children may see significant improvements in their academic performance. Second, students’ confidence in their academic abilities in each subject area were strong predictors of performance, so working to improve their self-concept and self-efficacy would be beneficial. Helping children achieve early academic successes upon which they can build may lead to improvements in self-concept and a willingness to engage in more complex and challenging learning in the future. The more children believe in their own academic abilities, and understand that their efforts lead to success, the more likely they are put in the time and focus needed to be successful academically. Helping children see the connection between their efforts and their achievement is a necessary first step (Dweck,
Finally, given that cardiorespiratory fitness predicted achievement across both tests, even after controlling for SES and academic self-concept, it makes sense to dedicate time in which children can be physically active, such as during PE classes, to have opportunities to become more fit. Although districts often view PE classes as secondary to their academic mission (e.g., Grissom, 2005), our data suggest that students’ are likely to receive tangible academic benefits from their involvement in PE classes and by improving their cardiorespiratory fitness. If PE classes are not possible, schools might consider supporting before school walking programs for kids who arrive early or after school programs that allow students’ access to the gyms and other areas to be physically active. Our results indicate that students’ academic achievement is influenced, at least in part, by how physically fit they are.

We examined the relative predictive utility of physical and psychosocial variables in predicting middle school students’ academic performance on state-mandated math and reading examinations. After controlling for the students’ families’ SES level as well as the students own academic self-concept, we found that level of cardiorespiratory fitness was the one consistent predictor of how they performed. This finding has policy implications when it comes to whether, and for how long, students will take PE classes, and what communities are doing to provide children and adolescents with easy and safe access to environments, such as parks, where they can be physically active. It also highlights the importance of students having opportunities to develop their cardiorespiratory fitness, whether in school-sponsored PE classes or through community or private sport and activity opportunities.
References


