Associations between Physical Fitness and Academic Achievement:

A Meditational Analysis

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Thesis Prepared for the Degree of

MASTER OF SCIENCE

UNIVERSITY OF NORTH TEXAS

May 2015

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Research has illustrated the interrelatedness of childhood physical fitness and psychological wellbeing, psychological wellbeing and academic achievement, as well as physical fitness and academic achievement. In this study, we proposed that psychological wellbeing (self-esteem and depression) serves as a mediator between physical fitness and academic achievement during adolescence. In a sample of middle school children \((N = 1,530)\), significant correlations were found between all three variables \((p \leq .0001)\). A hierarchical regression analysis was performed to assess the associations between physical fitness, psychological wellbeing, and academic achievement. The regression analysis reported a significant partial mediation effect. The results of this study supported the proposed hypotheses, including a mechanism of psychological wellbeing partially mediating the relationship between physical fitness and academic achievement. The findings of this study support the importance of encouraging activities to promote both physical fitness and psychological wellbeing in schools.
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ASSOCIATIONS BETWEEN PHYSICAL FITNESS AND ACADEMIC ACHIEVEMENT: A MEDIATIONAL ANALYSIS

The physical health benefits of childhood physical activity and physical fitness have been well researched (see Rowland, 2005 for a review). Over the past few decades, research has demonstrated the benefits of increased levels of physical activity and physical fitness on mental health (e.g., Davis et al., 2011). Research has illustrated the interrelatedness of childhood physical fitness and psychological wellbeing (e.g., Bonhauser et. al., 2005; Greenleaf, Petrie, & Martin, 2010; 2014), psychological wellbeing and academic achievement (e.g., Chow, 2007; 2010), as well as physical fitness and academic achievement (e.g., Chen, Fox, Ku, & Taun, 2012; Coe, Peterson, Blair, Schutten, & Peddie, 2012). Whilst research strongly supports the individual associations between physical fitness, psychological wellbeing, and academic achievement, the underlying mechanisms of those associations are not yet fully understood.

Although they are related, physical activity and physical fitness are separate constructs. Physical activity is a behavior, and can be defined as “voluntary movement produced by skeletal muscles that results in energy expenditure” (Chomistek, Chasman, Cook, Rimm, & Lee, 2013, p. 692). Physical activity can lead to physical fitness, which can be defined as “a set of attributes people have or achieve related to health or athletic ability” (Chomistek et al., 2013, p. 692). Physical fitness has been proposed as a mediator of the positive effects of physical activity on both psychosocial and physical health (Tomporowski, Lambourne, & Okumura, 2011).

To understand the benefits of health-related physical fitness, The Cooper Institute developed the FITNESSGRAM® assessment tool (see Meredith & Welk, 2010) which categorizes children and adolescents into either a Healthy Fitness Zone™ (HFZ™) or Needs Improvement Zone (NIZ) based on their physical fitness performance in the important areas of
cardiorespiratory, body composition, muscular strength and endurance, and flexibility. The results of the FITNESSGRAM assessment take into account gender and age (see Welk, Jackson, Morrow, Haskell, Meredith, & Cooper, 2010). The cardio-respiratory fitness (CRF) and body composition (i.e., body mass index [BMI], skinfold test) portions of the FITNESSGRAM assessment further separate individuals placed into the NIZ by categorizing them as higher risk or low risk. Individual measures of CRF with the results of body composition can be converted into VO2max levels, which is an important determinant of an individual’s endurance capacity during prolonged, sub-maximal exercise. VO2max levels can be easily compared to national standards (see Sanders & Duncan, 2006).

Individuals who fall within the HFZ also demonstrate strong physical and psychological protective factors against depressive symptoms (Rieck, Jackson, Martin, Petrie, & Greenleaf, 2013). Ortega and colleagues (2010) suggested that higher levels of CRF are associated with higher levels of psychological wellbeing. These psychological factors may then lead to benefits in other areas, including academic achievement. There is a need for further research to clarify the associations between physical fitness, psychological wellbeing, and academic achievement. Additionally, there is a need for further research to clarify any mechanisms or processes that may underlie those associations.

Proposed Model

Cottrell, Northrup, and Wittburg (2007) suggested that psychosocial variables, including depression and low self-esteem, are related to childhood obesity as well as children’s academic performance. To examine this association, Tomporowski and colleagues (2011) proposed a theoretical model of the inter-associations between physical fitness and academic achievement. This model posits that CRF and self-esteem are directly associated with academic achievement.
Furthermore, the strength of this association may be mediated by psychosocial variables (Tomporowski et al., 2011).

The complexities of predictors and ramifications of childhood participation in physical activity support a multi-faceted ecological model of behavior. This model can include personal behavioral influences (i.e., psychological, biological) as well as environmental factors (Wittberg, Northrup, & Cottrel, 2009). Given the significant prophylactic effects associated with increased physical activity and CRF, these variables have been studied within the context of decreased symptoms of depression in children and adolescents (Rieck et al., 2013).

Researchers have proposed physiological as well as psychological mechanisms to explain the associations found between physical fitness and academic achievement (Kwak et al., 2009). Routine participation in physical activity has been found to have biological effects by increasing neurons, dendrites, and synapses, which are essential structural elements in the central and peripheral nervous systems (Reed et al., 2010). Overall, individuals with depressive symptoms tend to be less active and less physically fit than individuals without those symptoms (Nabkasorn et al., 2005). This suggests an association between psychological and physiological wellbeing, and may indicate a predisposition for mental health disorders in individuals with reduced levels of physical fitness.

When negative views of the self, future experiences, and current experiences are maintained, elevated depression symptoms can develop (Shomaker et al., 2012). Adolescents with clinical levels of depressions exhibit increased problematic patterns in academic environment, and earn lower scores on subjective academic measures, such as self- and parent-report measures and grade point averages (Quiroga et al. 2013).
The association between exercise and positive mood may be explained by psychophysiological mechanisms (Donaghy, 2007). There may be links between exercise and self-perceptions, including body image and self-esteem. Self-esteem has been found to be positively associated with physical activity (Kwak et al., 2009). In turn, physical activity during the school day may improve academic performance through increased levels of blood flow throughout the brain and body, which may enhance arousal levels, as well as changing the levels of hormones secreted (Dwyer et al., 2001). Additionally, the mechanisms through with academic improvement is achieved through increased levels of physical activity and improved physical fitness, particularly through participation in physical education courses can include reduced boredom and increased physiological and emotional arousal, which may improve students’ attention spans and concentration abilities (Coe et al., 2006).

Fitness and Academic Achievement

Reviews of the association between cognitive functioning and physical activity have suggested that regular physical activity is associated with increased cognitive performance as well as improved classroom behavior and academic outcomes in children (Biddle & Asare, 2011). Reed and colleagues (2010) found evidence to support their proposition that movement can increase children’s fluid intelligence. Chen, Fox, Ku, and Taun (2012) found that increased levels of cardiovascular fitness were significantly associated with increased levels of academic performance. Positive associations have been found between academic achievement and cardiovascular fitness (CVF; Reed, Einstein, Hahn, Hooker, Gross, & Kravitz, 2010) and cardio-respiratory endurance (Eveland-Sayers, Farley, Fuller, Morgan, & Caputo, 2009).

There is a general trend of a positive association in overall levels of fitness and performance on both verbal and mathematics standardized tests (e.g., Eveland-Sayers et al.,
2009; Kwak et al., 2009; Reed et al., 2010). Academic achievement has been linked to CVF through its positive association and the potential mediation between physical activity and cognitive performance (Kwak et al., 2009). Subjective measures of academic achievement and cardio-respiratory endurance have been positively related to increased cognitive activity (Eveland-Sayers et al., 2009). Cross-sectional evidence indicates a positive association between higher levels of physical activity and increased academic performance (Kwak et al., 2009). Systematic reviews on physical activity and cognitive functioning have provided evidence that routine physical activity can be associated with improved cognitive performance, classroom behavior and academic achievement in young people (Biddle & Asare, 2011).

Dwyer, Sallis, Blizzard, Lazarus, and Dean (2001) have proposed a potential causal association between physical activity and academic performance. Research has indicated a significant positive association between physical fitness and performance on standardized testing in both middle and high school students (Castelli, Hillman, Buck, & Erwin, 2007). Coe, Pivarnik, Womack, Reeves, & Malina (2006) also found an association between increased levels of physical activity and higher grades in students across grade levels.

**Fitness and Psychological Wellbeing**

For the purpose of this study, psychological wellbeing (PWB) is understood as a combination of depression and self-esteem (Greenleaf, Petrie, & Martin, 2014); high levels of PWB are comprised of low depression and high self-esteem scores, whilst low levels of PWB are comprised of high depression and low self-esteem scores. An increasing body of research suggests that regular physical activity results in physiological changes in the brain (Knubben, Reischies, Adli, Schlattmann, Bauer, & Dimeo, 2007), and that endurance training can quickly lead to a substantial improvement in mood in individuals who have been diagnosed with clinical
levels of depression (Knubben et al., 2007). A systematic review indicated a positive effect of physical activity on decreasing symptoms of depression, anxiety, and behavioral problems in both children and adolescents (Ekeland, Heian, & Hagen, 2005).

Research has found that improvements in CRF lead to improvements in the overall psychological wellbeing in adolescents and children (Morales et al., 2013). Ortega and colleagues (2008) found a positive association between VO2\text{max} and the mental health of children and adolescents. VO2\text{max}, operationally defined as oxygen uptake at maximal exertion, is a way to measure the body’s capacity for aerobic work (Salmon, 2001). Higher VO2\text{max} scores were related to improvements in psychological wellbeing, including reductions in symptoms of depression (Kelly et al., 2011). Cross-sectional evidence suggests that more time spent in moderate-to-vigorous physical activity is negatively related to depressive symptoms (Webb, Benjamin, Gammon, McKee, & Biddle, 2013). Increased levels of CRF may serve as a protective mechanism against symptoms of depression (Rieck et al., 2013). Increases in physical fitness levels, including cardiovascular fitness, flexibility, and strength, have been associated with improvements in overall physical and psychological wellbeing (Kramer & Erickson, 2007).

In addition to its effects on depression, physical activity and increased physical fitness can improve levels of self-concept and self-esteem (Calfas & Taylor, 1994). Exercise may provide an increased perception of control, help to release anger or other negative emotions, and could serve as a distracter from depressive thoughts (Knubben et al., 2007). Additionally, physical activity and fitness could lead to mastery and success experiences, which could lead to improvements in adolescents’ self-esteem (Calfas & Taylor, 1994). Regular participation in physical activity has been associated with higher levels of self-esteem and lower levels of anxiety symptoms in children (Calfas & Taylor, 1994; Sothern et al., 1999). Increased levels of
childhood physical activity and physical fitness may reduce the risk of experiencing depressive symptoms in adolescence and adulthood (Rieck et al., 2013). Rieck and colleagues (2013) found that improvements in VO$_{2\text{max}}$ were associated with decreased levels of depression, while controlling for BMI, body fat percentage, and weight loss.

Researchers have suggested that there is some evidence that supports a causal association between physical fitness and psychological wellbeing (Biddle & Asare, 2011). Increased amounts of physical exercise have been found to be as effective as cognitive-behavioral therapy in reducing symptoms of depression; exercise may also be as effective as antidepressants in reducing symptoms experienced over a six-month period (Donaghy, 2007). Overall, research suggests that individuals who are physically active are less likely to experience mental health symptoms and may have advanced cognitive functioning than their peers who are less physically active (Biddle & Asare, 2011). Subclinical levels of depression in adolescents may be related to academic underachievement as well as other negative indicators of psychological wellbeing (Nabkasorn et al., 2005).

A potential explanation of this association is that symptoms of depression may encourage above-average weight gain during adolescence, which may be a result of decreased levels of physical activity and physical fitness (Shomaker, Tanofsky-Kraff, Zocca, Field, Drinkard, & Yanovski, 2012). Subsequently, children may experience decreased energy levels, a change in their sleeping or eating patterns, or a change in their desire to participate in activities; all of these are symptoms of depression. The decreased desire to participate in activities in which they previously enjoyed may be a side effect of lowered self-esteem.

Self-esteem is a key aspect of psychological wellbeing because of “(a) its close association with emotional stability and adjustment, (b) low self-esteem features in many forms
of mental illness and (c) low self-esteem is associated with poor health behaviors” (Fox, 1999, p. 413). Individuals with depression symptoms often have a negative self-concept and experience feelings of low self-esteem (Fox, 2000). Physical activity may lead to an improvement in self-esteem and self-concept among individuals with symptoms of depression (Ossip-Klein et al., 1989; Blumenthal et al., 1999); which could therefore be a mediator of the association between fitness and depression (White, Kendrick, & Yardley, 2009).

Ickovics, Carroll-Scott, Peters, Schwartz, Gilstad-Hayden, and McCaslin (2014) looked at students’ overall health and academic achievement levels; they found results that suggest a significant association between students’ health and academic achievement. Research indicates that increased levels of exercise and fitness can improve children’s self-esteem (Ekeland et al., 2005). The association between self-esteem and physical fitness may be reciprocal (Elavsky et al., 2005). Children and adolescents with higher BMI scores are more likely to experience symptoms of depression and lower self-esteem; however, higher levels of physical activity can negate these (London & Castrechini, 2011). Consistent exercise may decrease levels of depression and anxiety symptoms, as well as non-clinical levels of stress, that may influence academic performance, which can subsequently increase self-esteem (Chomitz, Slining, McGowan, Mitchell, Dawson, & Hacker, 2009).

**Psychological Wellbeing and Academic Achievement**

There may be a bi-directional relationship between depression and academic achievement. Cognitive, cognitive-behavioral, interpersonal, psycho-social, and contextual theories are able to explain the causal depressive symptom-GPA association by hypothesizing a direct association or a mediated third-variable mechanism (Hishinuma, Chang, McArdle, & Hamagami, 2012). Symptoms of depression and the lack of academic success during
adolescences have been associated with adult recurrence of depression, difficulties in psychosocial functioning, and other co-morbid symptoms (Hishinuma et al., 2012). Additionally, depressed individuals may experience more pessimistic views about themselves and future events, as well as of their ability to successfully influence or change their outcomes (Quiroga, Janoz, Bisset, & Morin, 2013).

Researchers have suggested a difference between actual academic outcomes and the students’ perceived competence in academic areas. Increased self-esteem can predict improvements of classroom behavior as well as improved academic performance (Coe et al., 2006). Students’ beliefs about their abilities to direct their own learning, or their perceived academic competence, have been suggested to be a significant predictor of academic success when controlling for previous academic achievement (Zuffiano, et al., 2013). Baumeister, Campbell, Kruegger, and Vohs (2003) found a positive association between academic achievement and self-esteem. Higher levels of self-esteem may increase focus and performance in classroom environments (Santiago, Roper, Disch, & Morales, 2013).

The positive association between self-esteem and physical activity may be an important factor in the psychological mechanism at work (Kwak et al., 2009). Through an association with increased self-esteem, higher levels of physical activity may improve academic performance and classroom behaviors (Coe et al., 2006). Regular physical activity may lead to improvements in perceived competency and self efficacy, which could be generalized into global self-esteem as well as other factors of psychological wellbeing (Fox, 1999).

After controlling for family structure and socio-economic status (SES), Coe and colleagues (2006) found a significant association between increased physical activity and increased self-esteem. This may be an explanation for increased academic success as an outcome.
of increased levels of physical activity (Tremblay, Inman, & Willms, 2000). Tremblay, Inman, & Willms (2000) completed a study that examined the association between physical activity and self-esteem; however, there is a dearth of association that examines the role that psychosocial wellbeing plays in mediating the association between physical fitness and academic achievement.

**Support for Mediation**

Accelerated psychomotor development; reduced feelings of tension, anxiety and stress; and elevated self-esteem are potential psychological mechanisms that have been reported to explain the possible association between fitness and academic achievement (Kwak et al., 2009). Cognitive-behavioral theories of depression that emphasize that depressed mood states prompt behavioral withdrawal from activities such as exercise, which in turn further exacerbates depressed mood (Shomaker et al., 2012). Routine and consistent exercise can lead to lower levels of anxiety and depression symptoms, which can in turn influence academic achievement (Bass, Brown, Laurson, & Coleman, 2013).

Within an elementary school setting, a primary goal of teachers and administrators is to increase students’ levels of self-esteem, as “it is considered to be an underlying factor determining student motivation, persistence, and academic success” (Tremblay, Inman, & Willms, 2000, p. 313). However, the connections between self-esteem and psychological wellbeing and subsequently psychological wellbeing and physical fitness suggest that there is a more complex mechanism at work that contributes to the observed increases in academic performance.

Self-esteem has been researched as an important predictor of many facets of human behavior, including academic performance, as well as a mediator of other psychological states
(Calfas & Taylor, 1994). The causation runs predominantly from disadvantage to distress rather than the reverse (McLeod, Uemura, & Rohrman, 2012). According to results from the Medical Outcomes Study, depressive symptoms and clinical levels of depression are associated with decreased levels of physical fitness and social wellbeing (Heiligenstein & Guenther, 1996). All forms of depression, ranging from exhibiting symptoms of depression to clinically-diagnosed Major Depressive Disorder, significantly interfere with functioning at home, work, or school at higher levels than the interference found with eight major chronic medical conditions (Heiligenstein & Guenther, 1996).

Shomaker and colleagues (2012) found a significant negative correlation between adolescents’ depressive symptoms and their self-reported levels of physical activity, exercise, and sport participation. Longitudinal data suggest that an increase in adolescents’ depression symptoms are significantly associated with decreases in their self-reported levels of physical activity (Shomaker et al., 2012). As physical activity can contribute to increases in self-concept and self-esteem, individuals with higher levels of symptoms of depression may benefit more from increased amounts of physical activity (Calfas & Taylor, 1994).

The Current Study

Rieck and colleagues (2013) suggested that there is a need for research that will clarify the associations between physical variables and psychological wellbeing outcomes. This study aims to investigate the associations between physical fitness, psychological wellbeing, and academic achievement through a meditational model. Consistent with the theoretical framework proposed by Tomporowski and colleagues (2011), psychosocial factors are proposed as mediators that affect the primary relationship between physical fitness and academic achievement. Additionally, Tomporowski and colleagues (2011) suggested that there might be
gender differences among this mediation, particularly for middle school children. Thus, this study was designed to answer the following research questions for males and females separately:

1. Is there a significant association between physical fitness and academic achievement?
2. Are there significant associations between physical fitness and psychological wellbeing and between psychological wellbeing and academic achievement?
3. Does psychological wellbeing mediate the association between physical fitness and academic achievement?

Based on these questions, the following hypotheses were proposed:

1. For both males and females, there will be a significant, positive association between physical fitness and academic achievement.
2. For both males and females, there will be a significant, positive association between physical fitness and psychological wellbeing.
3. For both males and females, there will be a significant, positive association between psychological wellbeing and academic achievement.
4. For both males and females, psychological wellbeing will partially mediate the association between physical fitness and academic achievement.
METHODS

Participants

The students who participated in this study were recruited from six middle schools in the Dallas-Fort Worth, Texas area. At the time of participation, students were enrolled in grades 6-8 and ranged from 10 to 15 years of age ($M = 12.81$, $SD = 0.950$). Broken down by federal race codes, 45.6% of participants were White, 27.2% were Hispanic/Latino, 6.9% were Black or African American, 2.8% were Asian, 0.6% were American Indian or Alaska Native, and 0.5% were multiple races.

Measures

Physical fitness. To assess participants’ physical fitness, the VO$_{2\text{max}}$ measurement was used. This equation is the standardized measure of aerobic fitness. Aerobic fitness, or the body’s capacity of aerobic work, has been operationally defined as oxygen uptake at maximal exertion (Salmon, 2001). The VO$_{2\text{max}}$ value is calculated by a formula based on body mass index (BMI), age, gender, and the participant’s score on the Progressive Aerobic Cardiovascular Endurance Run (PACER; Leger & Lambert, 1982; Leger, Mercier, Gadoury, & Lambert, 1988) from the FITNESSGRAM® (Meredith & Welk, 2010), and is expressed in terms of mL/kg/min. VO2max scores ranged from 25.81 to 70.72 ($M = 46.656$, $SD = 5.297$).

Depression. The Center for Epidemiologic Studies-Depression Scale (CES-D; Radloff, 1977) was developed to assess affective and somatic symptoms of depression in adults. Although initially developed for adults, the CES-D has been widely used with youth and has shown similar psychometric properties (Roberts, Andrews, Lewinsohn, & Hops, 1990). The scale assesses symptoms along four factors: negative affect (NA), positive affect (PA), somatic symptoms (SS), and interpersonal symptoms (IS). Skriner & Chu (2014) provide support for the use of the CES-
D in a cross-ethnic population. Participants respond to the 20 items about their symptoms in the past week on a 4-point Likert scale, ranging from 0 (*rarely or none of the time*) to 3 (*most of or all of the time*).

The child version of the CES-D, the Center for Epidemiological Studies Depression Scale for Children (CES-DC; Faulstich, Carey, Ruggiero, Enyart, & Gresham, 1986) is a frequently-used screener for the assessment of depressive symptoms in children between the ages of 6-17 (Essau, Olaya, Pasha, Gilvarry, & Bray, 2012). The CES-DC consists of 20 items adapted from the CES-D; total scores range from 0-60, with higher scores representing higher levels of depressive symptoms. The CES-DC has been used in both clinical and non-clinical populations (Fendrich, Weissman, & Warner, 1990), and has strong internal validity scores, with Cronbach’s alpha values between .71 and .91 (Barkmann, Erhart, & Schulte-Markword, 2008; Li, Chung, & Ho, 2010). Scores on the CES-D ranged from 0 to 58 ($M = 12.76$, $SD = 10.194$).

**Self-esteem.** The Physical Self-Description Questionnaire (PSDQ; Marsh, 1994) is a leading multidimensional instrument measuring self-concept in adolescents. It is comprised of 11 factors that measure the multidimensional, hierarchical formulation of self-concept: appearance, body fat, coordination, endurance, flexibility, general physical self-concept, health, physical activity, self-esteem, sport competence, and strength. For the purpose of this study, only the scores on the general sub-scale of self-esteem were used. Participants are asked to rate items on a six-point Likert scale (false, mostly false, more false than true, more true than false, mostly true, true). The constructs measured by the PSDQ have shown strong divergent and convergent validity (Schipke & Freund, 2012; Marsh, Asci, & Thomas, 2002). A meta-analysis of PDSQ reliability scores indicated that the self-esteem subscale has a mean Cronbach’s alpha score of
.875, with a range from .670-.970 (Schipke & Freund, 2012). In this study, scores on the self-esteem scale ranged from 12 to 40 ($M = 33.967, SD = 4.707$).

**Academic achievement.** Academic achievement was assessed by participants’ scores on the math and verbal standardized achievement tests in Texas: the State of Texas Assessment of Academic Readiness (STAAR). The STAAR is a criterion-referenced test that aligns with the State of Texas Curriculum Standards (Johnson, Wilson, & Williams-Rossi, 2013). Raw scores on the STAAR assessment range from 0-52 for reading achievement and 0-55 for math achievement (Texas Education Agency, 2012). In this study, STAAR reading scores ranged from 7 to 51 ($M = 37.70, SD = 7.395$). STAAR math scores ranged from 8 to 55 ($M = 36.05, SD = 9.895$).

**Procedures**

After receiving permission from both the university’s Institutional Review Board for Human Subjects Research and principals at each participating school, parental informed consent and student assent was obtained for each participating student. The relevant questionnaires were administered as part of a larger research study that was in conjunction with state FITNESSGRAM® physical testing during the 2011-12 academic year. Students completed the questionnaires during their regularly-scheduled physical education classes. Students were not required to provide any identifying information other than their student ID numbers, which were used to match their FITNESSGRAM® information to their questionnaires. Students who completed the questionnaires were entered into a prize drawing for several $10.00 cash prizes.

**Data Analysis**

Prior to statistical analysis, a missing variable analysis (MVA) was conducted. The primary data analysis method was a hierarchical regression to test the mediation model (see Figure 1). Baron and Kenny (1986) proposed a three-step mediation analysis. In Step 1, the
primary association between physical fitness and academic achievement was tested (Path C). If a significant association is found, the analysis will move on to Step 2. In Step 2, the primary associations between physical fitness and psychological wellbeing (Path A) and between psychological wellbeing and academic achievement (Path B) were tested. In Step 3, the mediation was tested via a hierarchical regression in SPSS. This regression will determine if the inclusion of the mediator (psychological wellbeing) accounts for the association between physical fitness and academic achievement (Path C’).

To avoid possible confounds by gender and academic differences, multiple regression analyses were run. Separate mediation analyses were conducted for males and females (as suggested by Tomporowski et al., 2011) as well as separate analyses for math and verbal outcome measures. A total of four models were tested: (a) boys reading achievement, (b) boys math achievement, (c) girls reading achievement, and (d) girls math achievement.
RESULTS

Prior to statistical analysis, a variable to represent psychological wellbeing (PWB) was created. First, the total CES-DC scores were standardized to Z-scores. The scores on the self esteem (SE) scale of the PDSQ were also standardized to Z-scores. The variable of PWB was created by subtracting the depression Z-score from the SE Z-score (SEZ-DEPZ). The PWB variable scores ranged from -5.52 to 2.50, with a mean of 0.074 with a standard deviation of 1.686. To test the assumption of normality, descriptive statistics were run to check for skewness and kurtosis. All variables were found to have acceptable levels (i.e., within -3.00-3.00; Tabachnick & Fidell, 2001) of skewness and kurtosis.

**Hypothesis 1.** To test Hypothesis 1, a series of one-tailed Pearson’s $r$ correlation analyses were run to examine the relationship between physical fitness and academic achievement. For males, physical fitness and reading achievement were significantly correlated, $r = .143, p = .01$. Males also showed a significant correlation between physical fitness and math achievement, $r = .142, p = .01$. While these correlations were significant, male’s physical fitness had a very weak correlation with reading achievement and only 2% of the variation in reading achievement was accounted for by physical fitness ($R^2 = .020$). The correlation between male’s physical fitness and math achievement was also very weak, with physical fitness accounting for 2% of the variation in math achievement ($R^2 = .020$).

For females, there was a significant correlation between physical fitness and reading achievement, $r = .081, p = .05$. Females also showed a significant correlation between physical fitness and math achievement, $r = .094, p = .01$. However, these correlations were negligible; physical fitness accounted for 0.6% of the variation in reading achievement and 0.8% of the variation in math achievement (reading $R^2 = .006$; math $R^2 = .008$).
Hypothesis 2. To test Hypothesis 2, two one-tailed correlation analyses were run to examine the relationship between physical fitness and psychological wellbeing. For males, there was a significant correlation between physical fitness and psychological wellbeing, $r = .191, p = .01$. For females, there was also a significant correlation found, $r = .068, p = .05$. While these results are significant, the correlation between physical fitness and psychological wellbeing in males was very weak; physical fitness accounted for 3.6% of the variation in psychological wellbeing ($R^2 = .036$). Additionally, the correlation between physical fitness and psychological wellbeing is negligible, with physical fitness accounting for 0.5% of the variation of psychological wellbeing ($R^2 = .005$).

Hypothesis 3. To test Hypothesis 3, two one-tailed correlation analyses were run separately on each gender to examine the relationship between psychological wellbeing and academic achievement. For males, there was a significant correlation between PWB and reading achievement, $r = .302, p = .01$. This correlation was weak, with PWB accounting for 9% of the variation in reading achievement ($R^2 = .091$). Males also showed a significant but weak correlation between PWB and math achievement, $r = .234, p = .01 (N = 691)$. In this correlation, PWB accounted for 5.5% of the variation in math achievement ($R^2 = .055$).

For females, there was a significant but weak correlation between PWB and reading achievement, $r = .276, p < .0001$, with PWB accounting for 7.6% of the variation in girls’ reading achievement ($R^2 = .076$). There was also a significant but weak correlation between PWB and math achievement, $r = .264, p < .0001$. PWB accounted for 6.9% of the variation in girls’ math achievement ($R^2 = .069$).

Hypothesis 4. For the regression analysis, the process recommended by Preacher & Hayes (2008) was followed to test the simple mediation model. Preacher & Hayes (2008)
provided a macro that was downloaded and used as SPSS syntax to perform the mediation analysis.

Separate analyses were run for gender (male and female) and outcome (math and reading achievement) variables. A linear regression was used to test if the variance in males’ reading achievement was accounted for by psychological wellbeing and physical fitness. The results of the regression indicated the two predictors explained 10% of the variance (Adjusted $R^2 = .099$, $F(2,643) = 36.464, p < .0001$). It was found that the total effect of physical fitness on reading achievement (Path C) was significant ($\beta = .194, p < .0001$); the direct effect of the mediation (Path C’) was also significant ($\beta = .118, p = .022$) (see Figure 2).

The mediation model indicated that physical fitness and psychological wellbeing accounted for approximately 6% of the variance in males’ math achievement (Adjusted $R^2 = .064$, $F(2,643) = 23.148, p < .0001$). It was found that the total effect of physical fitness on math achievement (Path C) was significant ($\beta = .246, p = .0003$); the direct effect of the mediation (Path C’) was also significant ($\beta = .174, p = .010$) (see Figure 3).

The mediation model indicated that physical fitness and psychological wellbeing accounted for approximately 7% of the variance in females’ reading achievement (Adjusted $R^2 = .075$, $F(2,712) = 30.047, p < .0001$). It was found that the total effect of physical fitness on reading achievement (Path C) was significant ($\beta = .117, p = .031$); the direct effect of the mediation (Path C’) was not significant ($\beta = .091, p = .083$) (see Figure 4).

The mediation model indicated that physical fitness and psychological wellbeing accounted for approximately 8% of the variance in females’ math achievement (Adjusted $R^2 = .073$, $F(2,712) = 29.086, p < .0001$). It was found that the total effect of physical fitness on
reading achievement (Path C) was significant ($\beta = .194$, $p = .012$); the direct effect of the mediation (Path C’) was also significant ($\beta = .158$, $p = .034$) (see Figure 5).
DISCUSSION

Results from this study supported Hypothesis 1, which proposed that there was a significant, positive association between physical fitness and academic achievement. Hypothesis 2 was also supported, as a significant, positive association between physical fitness and psychological wellbeing was found. Hypothesis 3 was supported, as there was a significant, positive association between psychological wellbeing and academic achievement. Finally, Hypothesis 4 was partially supported when psychological wellbeing was found to partially mediate the association between physical fitness and reading and math achievement in males and between physical fitness and math achievement in females; however, no significant mediation was found for the female reading achievement model.

The results from this study are in line with previous findings of a significant positive relationship between physical fitness and academic achievement as well as a significant positive relationship between psychological wellbeing and academic achievement. Although the percentages for variances explained were all weak or negligible, significant partial mediations were found for three of the models, supporting the proposed mechanism of psychological wellbeing mediating the relationship between physical fitness and academic achievement.

The results found in this study support previous findings of a significant link between physical fitness and depression (i.e., Rieck et al., 2013). For males and females, the relationship between self-esteem, a component of psychological wellbeing, and academic achievement was stronger than that of depression, the other component of psychological wellbeing, and academic achievement. This suggests that for children in middle school, higher levels of self-esteem may counter any negative effects of depression that may be impacting their academic achievement.
A weak but significant relationship between physical fitness and academic achievement is consistent with current understandings of what can influence academic achievement (i.e., Bass et al., 2013). The partial mediation found in this study is consistent with previous findings as to what may contribute to the relationship between physical fitness and academic achievement. Tomporowski and colleagues (2011) suggested that psychosocial variables, such as self-esteem and depression, might be mediators of this relationship. Further research in this area could continue to tease out individual psychosocial variables that could further contribute to the mediation process.

As the results supported a partial mediation, encouraging activities to promote both physical fitness and psychological wellbeing could be beneficial to improving academic achievement outcomes for students. Other factors that may contribute to the relationship between physical fitness and academic achievement may include student and teacher attitudes (Bass et al., 2013), children’s health status (Wittberg et al., 2012), as well as self-concept and self-efficacy (Aktop, 2010). Future studies could include these variables in a path analysis to increase understanding of the nature of the meditational relationship.

Limitations

As this study involved a cross-sectional sample, a causal relationship between variables cannot be assumed. The large sample size may account for the significant correlations that were found. A more accurate measure of the associations between variables may be the explained variance; in this case, these findings were all either weak or negligible.

Another limitation of this study is the dynamic and multifaceted nature of all three variables included in this research. For example, while the $\text{VO}_{2\text{max}}$ measure incorporates pacer score, BMI, and gender factors, is it unknown if the physical fitness itself or other correlated
concepts, such as body image and physical perceptions, that is related to academic achievement. Additionally, psychological wellbeing is complex. For the purposes of this study, only self-esteem and depression were included in the psychological wellbeing variable, but other factors could be also be included in future research.

Finally, this study was focused on standardized end-of-year assessments for reading of math as measures of academic achievement. Therefore, the results of this study cannot be assumed to apply to other areas of academic achievement. Future studies could include other measures of academic achievement, such as GPA, or focused on other arenas of academic performance.

Conclusions

This study contributes to a better understanding of the non-classroom-centered concepts that can contribute to improved academic performance. While there may be biological changes to the nervous system as a result of physical activity and improved physical fitness (Tomporowski et al, 2011), there are also psychosocial variables that can improve mental health and mental functioning in cognitive capacities. Physical activity may serve a preventative purpose for helping children to avoid future mental illness (Voderholzer, Dersch, Dickhut, Herter, Freyer, & Berger, 2011). Subsequently, prevention of mental health problems in school-aged children may increase their performance in school and enable them to achieve higher levels of education (McLeod, Uemura, & Rohrman, 2012).

If teachers and administrators at the lower levels of education can identify potential characteristics of their students that could be modified, such as physical fitness and psychological wellbeing, they will be able to implement practices that will promote increased academic achievement (Zuffiano, et al., 2013). Currently, the mainstream academic policies
focus on achievement, for both activities in the classroom and extra-curricular activities; this lack of attention to public health issues suggests a “low prioritization of health problems facing America’s youth” (Castelli, et al., 2007, p. 241). However, with research that indicates the relationship between physical and psychological health and academic performance, it is worth understanding this mechanism in hopes of suggesting changes in curricula and activities in education and public policy (Castelli, et al., 2007).
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Figure 1. The overall mediation model that was tested.

Figure 2. Male reading path coefficients.
Figure 3. Male math path coefficients.

Figure 4. Female reading path coefficients.
**Figure 5.** Female math path coefficients.