



Is there a Relationship between Body Mass Index, Fitness, and Academic Performance? Mixed Results from Students in a Southeastern United States Elementary School

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The purpose of this study was to investigate relationships between body mass index (BMI), physical fitness, and academic performance in elementary school students. Specifically, BMI and scores on the President's Challenge Physical Activity and Fitness Awards Program, a physical fitness test, were compared to reading and mathematics scores on the Florida Comprehensive Assessment Test (FCAT), a standardized norm-referenced academic achievement measure. Participants included 132 4th and 5th grade students from a k-12 school located in North Central Florida. Results revealed that BMI and physical fitness were correlated with academic performance for 5th grade females. In addition, there was a significant and negative association found between BMI and physical fitness across grade level and sex.

Keywords: obesity, overweight, physical education, President's Challenge, FCAT, fitness

The association between physical fitness and academic performance has received understandable attention in response to the growing prevalence of children who are overweight and out-of-shape (Ogden, Carroll, McDowell, Tabak, & Flegal, 2006), as well as demands placed on schools to produce students who meet academic standards (Castelli, Hillman, Buck, & Erwin, 2007). A potential relationship of fitness to cognitive functioning may be explained by both physiological and psychological mechanisms (Chomitz, Slining, McGowan, Mitchell, Dawson, & Hacker, 2009) as physical activity stimulates neural development (Studenski, Carlson, Fillit, Greenough, Kramer, & Rebok, 2006), enhances circulation, increases

blood flow to the brain, and raises levels of norepinephrine and endorphins—which collectively may decrease stress, improve mood, stimulate a calming effect after exercise, and as a result possibly improve academic performance (Taras, 2005; Fleshner, 2000; & Morgan, 1994). Yet, despite conceivable connections between physical fitness and academic outcomes, physical education (PE) in US schools is diminishing as emphasis on high-stakes tests increases (Rentner, Scott, & Kobert, 2007).
Physical Education

According to the National Center for Chronic Disease Prevention and Health Promotion, only 1 in 3 students participate in daily PE classes (NCCDPHP, 2010).

In addition, nationwide research suggests that few schools provide daily PE or its equivalent for all grade levels throughout the school year. For example, only 3.8% of elementary schools (excluding kindergarten), 7.9% of middle schools, and 2.1% of high schools provide daily PE throughout the year for all students (Kann, Brener, & Wechsler, 2007). This issue is gaining in popularity as the identification of the effects of physical fitness, and its components, on cognitive functioning could aid school administrators in the decision-making process (Castelli et al., 2007), particularly decisions related to the amount of time students should spend in core academic instruction versus PE. Thus, the matter of whether physical fitness has a meaningful impact on students' academic performance must be adequately explicated.

Despite a number of nationwide health initiatives to reduce childhood obesity by promoting healthy lifestyle behaviors, the diminution of PE in schools sends a resounding message to stakeholders that students' physical fitness has little to no bearing on their academic performance. The discounting of PE may inadvertently occur, due in part to The No Child Left Behind Act (NCLB, 2001) which mandated that schools evaluate the academic performance of all students *not* the physical fitness of all students, so it is easy to understand why many school administrators routinely place PE on the chopping block in favor of more mathematics, language arts, and science instruction. If compelling and overwhelming research existed showing a significant positive relationship between physical fitness and academic performance most administrators would likely place more emphasis on improving students' fitness. Unfortunately, research on the relationship between physical fitness and academic performance remains unclear.

Gender & Age

Given the substantial influence that gender and age have on children's educational experience (Cushner, McClelland, & Stafford, 2009), it is important to consider and control for these variables when conducting research that examines academic outcomes. Obesity, for example, is associated with decreased college enrollment particularly for females (Rimm, 2004), which suggests that females incur harsher educational repercussions for being overweight. In addition, overweight girls are more likely to experience greater social isolation and emotional distress compared to overweight boys (Faulkner, Neumark-Sztainer, Story, Jeffery, Beuhring, & Resnick, 2001). They also endure more relational victimization and suffer from less supportive and more antagonistic friendships (Pearce, Boergers, & Prinstein, 2002). On the other hand, larger boys are more likely to be praised for their size especially in the context of sports such as football in which bigger equals better.

Furthermore, boys and girls generally have different rates of growth and maturation that have important implications from a physiological standpoint. It is generally

accepted that puberty begins earlier for girls – often between 9 and 13 years of age while boys begin the process a year or more later in life (American Academy of Pediatrics, 1996). For many youth, puberty marks a period of doubt and challenges as they must deal with variations in hormone production that influence mood. Research indicates that depression-related differences in negative affect are especially pronounced for pubertal girls (Forbes, Williamson, Ryan, & Dahle, 2006). Taken together, these patterns could result in notable differences in how boys and girls across ages and weight statuses perform in school.

The Literature

Five studies were identified as being especially germane to this study. Chomitz et al. (2009) examined relationships between physical fitness and academic performance in diverse, urban public school children enrolled in 4th, 6th, 7th, and 8th grade. Academic performance was assessed as a passing score on the Massachusetts Comprehensive Assessment System (MCAS) achievement tests in mathematics and in English. Physical fitness was assessed as the number of physical fitness tests passed during PE class. Specifically, students completed an endurance cardiovascular test, an abdominal strength test, a flexibility test, an upper body strength test, and an agility test. These tests were adapted from the Amateur Athletic Union and FITNESSGRAM guidelines. Results revealed that the odds of passing both the MCAS Mathematics test and the MCAS English test increased as the number of fitness tests passed increased. Castelli et al. (2007) examined the relationship between physical fitness and academic performance in public school students enrolled in the 3rd and 5th grade. Participants completed the Progressive Aerobic Cardiovascular Endurance Run (PACER) to assess aerobic capacity and later completed push-ups and curl-ups to measure muscular strength. In addition, participants completed the back-saver sit and reach test to measure flexibility. Finally, participants completed the Illinois Standards Achievement Test (ISAT) in mathematics and reading to measure academic performance. Results revealed that field tests of physical fitness were positively related to academic performance in mathematics and reading. Specifically, aerobic capacity was positively associated with academic performance. Furthermore, there were significant effects for body mass index (BMI), indicating that lower BMI and higher aerobic fitness were positively related to mathematics achievement. Similarly, there were significant effects for BMI, and the PACER indicating that lower BMI and higher aerobic fitness were positively related to reading achievement. Grissom (2005) also evaluated the relationship between physical fitness and academic performance of students enrolled in 5th, 7th, and 9th grade. Scores on the FITNESSGRAM, a physical fitness test that measures aerobic capacity, body composition, curl-ups, trunk lifts, upper body strength, and flexibility were compared to reading and mathematics scores on the Stanford

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Achievement Test 9th (SAT/9) edition. Results revealed that when the overall physical fitness test score was compared to mean SAT/9 reading and mathematics scores, there was a consistent positive relationship between physical fitness and academic performance. This relationship appeared to be stronger for females than males and stronger for higher socioeconomic status (SES) than lower SES students.

While Kaestner and Grossman (2009) did not examine the relationship between physical fitness and academic performance, they did investigate the relationship between body weight and academic performance. Given weight's indubitable association with physical fitness, the study is considered to be relevant to the current investigation. In their study, the Peabody Individual Achievement Tests in mathematics and reading, and grade attainment were utilized to represent academic performance. Results suggested that, in general, children who were overweight or obese had academic test scores that were about the same as children with average weight.

Tremblay, Inman, and Willms (2001) examined the relationship between children's self-reported levels of physical activity and reading and mathematics scores of 6th grade students. Students' test scores in reading and mathematics were based on standardized tests administered by the New Brunswick Department of Education. The measure of physical activity was based on four questions regarding students' regular participation in physical activities. Although, physical *activity* and physical *fitness* are different constructs the study is deemed to be applicable since most physical activity guidelines consider fitness a surrogate measure of physical activity (Myers et al., 2004). Results revealed that physical activity had a trivial negative relationship with academic performance. Specifically, a one unit increase on the activity scale was associated with a reduction in test scores of 2-3% of a standard deviation.

Altogether, the research on this topic is mixed at best warranting additional investigation and elucidation. Furthermore, it appears that one of the most popular fitness tests, The President's Challenge Physical Activity and Fitness Awards Program (The President's Challenge), has *not* been utilized in previous investigations to measure students' physical fitness. Unlike other fitness tools such as FITNESSGRAM, the essential components of The President's Challenge are free or relatively inexpensive so the findings of this study may be more intriguing to many schools that cannot afford other fitness programs. In addition, few studies have utilized both academic and fitness raw scores to analyze student data. Raw scores have added value because they are more sensitive to variations in performance and can capture smaller differences (Flippo & Caverly, 2009). Finally, previous research on this topic has seemingly neglected the southeastern region of the United States. This is a significant omission since trends in childhood obesity are not constant across the nation. For instance, a recently identified cluster of states in the

southeastern portion of the country, referred to as the "diabetes belt," generates a significantly higher prevalence of diabetes and obesity than other parts of the country (Barker, Kirtland, Gregg, Geiss, & Thompson, 2011). Therefore, it is important to study all regions rather than make broad and potentially inaccurate generalizations based on a few.

Purpose of the Study

The purpose of this study was to examine relationships between BMI, physical fitness, and academic performance in 4th and 5th grade children. Specifically, the researchers sought to identify the relative contribution of BMI and physical fitness as correlates of academic performance in the study's sample. Unlike many previous investigations, the strength of the association between fitness and academic performance was examined by using both fitness and academic test's raw scores as continuous variables rather than dichotomized pass/fail factors. Additionally, the current study used fitness measures, procedures, and norms from The President's Challenge which has been understudied in comparison to its counterparts. Finally, the data were collected from students attending a school located in the southeastern region of the United States which helps fill the demographic void that exists in the current literature. It was hypothesized that increased BMI and low physical fitness would be associated with poor academic performance across grade level and gender.

Methods

Participants

The setting for the study was a k-12 school located in North Central Florida. This cross-sectional study included data on 132 children enrolled in 4th (n=66; 52% males) and 5th (n=66; 50% males) grade. The racial makeup of the sample was as follows: 44% White; 23% Hispanic; 22% Black; 7% mixed; 3% Asian; and 1% Native American. Gender (male/female), race/ethnicity (Asian, Black, Hispanic, and White), and SES were extracted from the school administration record system. The annual household income was as follows: 30% = \$97,750 or more; 22% = \$69,000 to 97,749; 24% = \$39,250 to 68,999; and 24% = \$0 to 39,249. A certified teacher in the PE Department annually measures students' height, weight, and physical fitness during PE class with students from kindergarten to eighth grade. Based on the Center for Disease Control and Prevention (CDC) age norms, children whose BMI z-score based on age and gender were greater than the 95th percentile were classified as obese ($n = 20$, 15%), children whose BMI were between the 85th and 95th percentile were classified as overweight/at-risk for overweight ($n = 19$, 14%), and children whose BMI were between the 6th and 84th percentile were classified as normal weight ($n = 82$, 62%). Three children (2%) had a BMI < 6th percentile and were excluded from the analyses to control for outlier effects (Hodge & Austin, 2004). For the purposes of this study, school record data that included

BMI, physical fitness, and academic test scores for students who were enrolled in 4th and 5th grade during the 2008-2009 academic year were used. The study protocol was reviewed and approved by the Behavioral/Nonmedical Institutional Review Board (IRB-02) of a southeastern university.

Data Collection

Physical fitness data were gathered from a series of fitness tests conducted by the PE teacher during regularly scheduled PE periods in March and April of 2009 as students completed physical fitness tests in five domains (curl-ups, shuttle run, one mile run/walk, pull-ups, flexed-arm hang, and V-sit reach) adapted from The President's Challenge. Fitness scores are based on the 1985 School Population Fitness Survey. The PE teacher and students followed The President's Challenge Program Manual to maintain objectivity in scoring. The President's Challenge recommends partner assistance in test administration and research indicates that it possesses acceptable reliability based on both instructor scores ($R_{c1} = .95$, $R_{d\ Total} = .69$) and student scores ($R_{c1} = .95$, $R_{d\ Total} = .73$; Killman & Barfield, 2008).

Curl-ups, a movement similar to sit-ups, were completed to measure abdominal strength and endurance by recording the maximum number of curl-ups performed in one minute. The PE teacher provided general guidelines and monitored students during each fitness test. For example during curl-ups, "bouncing" off the floor was not permitted. The *shuttle run* was completed to measure quickness and agility, and times were recorded to the nearest tenth of a second. The *one mile run/walk* was completed to measure cardiorespiratory fitness/endurance, and times were recorded in minutes and seconds. *Pull-ups* were completed to measure upper body strength and endurance. Recorded scores indicate the number of pull-ups that participants completed under non-timed conditions. *Flexed-arm hang* was also completed to measure upper body strength and endurance. To record a valid score students assumed the flex-arm hang position, held their chin over the bar, kept their chest close to the bar, and allowed their legs to hang straight. Timing was stopped when the student's chin touched or fell below the bar. The *V-sit reach* was completed to measure flexibility of the lower back and hamstrings by reaching forward in the V-position. To obtain a valid score, students were required to keep their legs straight while keeping the soles of their feet positioned perpendicular to the floor. Students were encouraged to reach slowly rather than "bounce" while stretching. V-sit reach scores were recorded to the nearest half-inch and are read as plus scores for reaches beyond baseline; and minus scores indicate reaches that were performed behind baseline. Weight status was assessed by BMI z scores based on height and weight measurements collected by the PE teacher in March and April of 2009. Height was measured to the nearest .25 inch and body weight was measured to the nearest ½ pound in light indoor clothing without shoes. BMI z scores were calculated and

categorized based on CDC protocol. For descriptive purposes, BMI-for-age percentiles for boys and girls were constructed using the CDC and Prevention/National Center for Health Statistics growth charts and categorized as: obese ($\geq 95^{\text{th}}$ percentile), overweight (between $\geq 85^{\text{th}}$ and $\leq 95^{\text{th}}$ percentile), normal weight (between $\geq 5^{\text{th}}$ and 85^{th}), and underweight ($\leq 5^{\text{th}}$ percentile).

Academic performance was measured using the Florida Comprehensive Assessment Tests (FCAT), which annually tests all students across the state, including students with disabilities and students with limited English proficiency. The FCAT was administered in March of 2009 by teachers in classrooms. As mandated by the Education Reform Law of 1993 and the federal NCLB Law from 2001, all students educated with public funds are required to participate in the FCAT administered in their grades. The FCAT is part of Florida's overall plan to increase student achievement by implementing higher standards. The FCAT, administered to students in Grades 3-11, consists of norm-referenced tests in reading and mathematics, which compares the achievement of Florida students with that of their peers nationwide; and criterion-referenced tests in reading, mathematics, science, and writing, which measure student progress toward meeting the Sunshine State Standards (SSS) benchmarks. FCAT raw scores in reading and mathematics range from 86 to 3008. These scores were used to interpret academic performance results.

Data Analytic Plan. Preliminary analyses were conducted to determine the normative distribution of each variable and to examine whether there were any statistically significant associations between demographic variables (i.e., sex, age, race, or SES), BMI, physical fitness, and academic performance. In addition, a principal component factor analysis was conducted to determine if the six fitness tasks loaded into a single fitness factor. As part of the primary analyses, we first conducted a univariate analysis of variance (ANOVA) to determine whether fitness levels differentiated children classified as overweight, obese, and normal weight. Correlational and regression analyses were then performed to examine whether fitness and BMI were related to academic performance. Separate correlational and regression analyses were computed for each grade given that the standardized academic test was different per grade.

Results

Preliminary Analysis

Descriptive statistics. In terms of the normative distribution of each variable, two fitness tasks were significantly skewed: pull-ups and flex-arm hang time (skewness value of 1.88 and 2.02, respectively). Flex-arm hang time was normalized via a log + 10 transformation. Given that a larger portion of children could not do a single pull-up (44%), this variable was categorized (children who could do a single pull-up or more versus children who could not do a single pull-up). All other variables had normative distributions.

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Next, preliminary analyses were conducted to determine any associations between demographic variables, physical fitness, and academic performance. Effect sizes were calculated using Cohen’s *d*. First, multivariate analyses indicated significant gender differences across various fitness variables, ($F(6, 54) = 7.34, p < .001, d = .82$). Specifically, boys performed significantly more sit-ups ($F(1, 59) = 8.63, p < .01, d = .15$), and had faster shuttle times ($F(1, 59) = 19.07, p < .001, d = .32$), and mile times ($F(1, 59) = 6.97, p < .05, d = .12$) than girls. While girls were more flexible than boys, ($F(1, 59) = 7.40, p < .01, d = .12$). No other significant associations were found among demographic variables and any of the study’s outcomes. Due to these significant sex differences, the primary analyses were conducted separately for boys and girls.

Data reduction and fitness factor. Academic reading and math scores were combined into a single academic performance variable due to their high correlation, $r = .69, p < .001$. In addition, the current study used 6 indicator variables to measure children’s fitness—mile time in minutes and seconds, shuttle time to the nearest tenth of a second, number of curl-ups, ability to do a pull-up, flex-arm hang time in seconds, and flexibility (V-stretch). Hence, a principal component factor analysis was first conducted to determine if these 6 indicator variables loaded into a single fitness factor. From this analysis, 2 factors emerged (i.e. Fitness factor 1 and fitness factor 2) with an eigenvalue above 1 ($\lambda = 1.05$) and these factors explained 63.51 percent of the total variance across measures for this sample. As seen in Table 1, all fitness tests, other than flexibility, had high loadings ($>.60$) on the first factor while the second factor was only comprised of flexibility. Consequently, all fitness scores, except flexibility, were standardized and combined, by averaging their total scores (reverse scoring was used for mile and shuttle times), into a single continuous fitness factor. This fitness factor, with higher scores indicating better fitness, was used in subsequent analyses.

Fitness and pediatric obesity. It was also

important to determine whether physical fitness levels differed according to weight groups. Accordingly, a univariate analysis of variance (ANOVA) was conducted to determine whether physical fitness levels differentiated children classified as obese, overweight/at-risk, and normal weight. Gender and grade were controlled, given their earlier relations to fitness. This analysis revealed a significant main effect for the weight groups ($F(2, 111) = 32.69, p < .001, \text{partial } \eta^2 = .37$), on fitness. As seen in Table 2, follow-up contrast tests with Bonferroni correction indicated that children classified as obese had significantly lower fitness levels ($M = -.90, SE = .15$) compared to both children classified as overweight/at-risk ($M = -.26, SE = .15$) and children classified as normal weight ($M = .35, SE = .07$), $p < .01$ and $p < .001$, respectively. Children classified as overweight/at-risk also had significantly lower fitness levels than children classified as normal weight, $p < .001$.

Associations between BMI, fitness, and academic performance. Correlational analyses were conducted to determine whether fitness level and BMI were associated with academic performance. Separate analyses were conducted for each grade level as well as for boys and girls. As seen in Table 3, these analyses revealed a significant positive association between fitness and academic performance, but only for girls in 5th grade.

Finally, a regression analysis (see Table 4) was conducted to determine whether for 5th grade girls, both BMI and fitness were uniquely associated with academic performance or if one variable was more important in this association. This analysis revealed an overall effect of BMI and fitness predicting academic performance, ($F(2, 24) = 5.58, p < .01, \text{total } R^2 = .32, d = .47$). However, only BMI marginally predicted academic performance, $\beta = -.40, p < .08$. Thus, 5th grade girls with higher BMI levels had worse academic performance. Fitness ($\beta = .21, p = .34$) no longer significantly predicted academic performance when BMI was in the model.

Table 1
Factor loadings from the principal component factor analysis

Fitness test	Fitness factor #1	Fitness factor #2
Mile Run Time	-.70	.35
Shuttle Time	-.76	.28
Sit-ups	.76	-.25
Pull-ups	.71	.27
Flex-arm hang Time	.68	.23
Stretch	.37	.81

Table 2
 Demographic characteristics, fitness levels, & academic scores according to weight group

	Normal Weight (n=82)	At-risk for overweight/overweight (n=19)	Obese (n=20)
Demographics			
Gender			
Male	46	9	12
Female	41	12	13
Race			
Caucasian	41	11	9
Minority	46	10	16
Age	10.6 (.77)	10.6 (.65)	10.7 (.74)
BMI	17.48 (.19)	21.70 (.39)	27.23 (.38)
Fitness Measures			
Mile run time (seconds)	633.6(135.9)	718.8 (146.5)	872.6 (207.1)
Shuttle time (seconds)	11.34 (.88)	11.94 (.87)	12.66 (1.30)
Sit-ups	34.98 (10.0)	31.1 (8.4)	26.6 (11.0)
Pull-ups	3.05 (3.64)	.21 (.58)	.12 (.33)
Flex-arm hang time (seconds)	21.08 (17.01)	5.53 (6.32)	3.41 (7.09)
Stretch	1.12 (3.96)	.10 (4.0)	-.77 (3.01)
Academic Measures			
Reading (FCAT)	1784.3 (220.9)	1763.1 (275.6)	1638.8 (277.6)
Math (FCAT)	1716.0 (213.2)	1683.8 (210.5)	1611.8 (203.0)

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Table 3
Associations between BMI, Fitness, and Academic Performance Across Groups

	BMI	Fitness Composite	Academic Performance
4 th Grade			
1. BMI	-	-.64***	-.15
2. Fitness Composite	-.64***	-	-.02
3. Academic Performance	.13	.07	-
5 th Grade			
1. BMI	-	-.63***	-.59**
2. Fitness Composite	-.50**	-	.42*
3. Academic Performance	-.15	.17	-

Note: Values above the diagonal are for girls; values below the diagonal are for boys. * p < .05, ** p < .01, *** p < .001.

Table 4
Regression Analyses

Grade and Gender	β	F	R ²	Standard Error
4 th Grade Female (n=32)	Fitness -.16 BMI -.25	.54	.04	169.91325
4 th Grade Male (n=34)	Fitness .26 BMI .29	.92	.06	202.966655
5 th Grade Female (n=33)	Fitness .21 BMI -.40	5.58**	.32	169.83254
5 th Grade Male (n=33)	Fitness -.03 BMI -.22	.54	.04	161.73034

+p<.08, *p <.05, **p <.01

Discussion

The purpose of this study was to examine the relationship between BMI, physical fitness, and academic performance in 4th and 5th grade children. Specifically, the researchers sought to identify the relative contribution of BMI and physical fitness as correlates of academic performance for boys and girls. Secondly, the researchers sought to determine the viability of a single fitness composite measure in terms of muscular strength, muscular endurance, aerobic capacity, and flexibility. It was hypothesized that higher BMI and lower physical fitness would be associated with poor academic performance across grade level and gender. Consistent with recent research (Chomitz et al., 2009; Castelli et al., 2007) results indicate a significant negative association between BMI and physical fitness across grade and gender with the effect size falling in the moderate range. The difference for males and females on sit-ups, the mile run, and flexibility was small, while the difference for males and females on the shuttle run was moderate. Furthermore, the difference for males and females across weight groups was moderate. Somewhat consistent with previous research (Knudson, Magnusson, & McHugh, 2000) the results indicate that flexibility did not load highly with other physical fitness variables. Thus, it is questionable whether flexibility should be considered a relevant indicator of physical fitness in children since its relationship with other measures of physical fitness is exceptionally weak.

Another key finding of this study was that BMI was moderately correlated with academic performance only in 5th grade girls. The finding that girls may be more impacted academically by being overweight is consistent with research from Datar and Strum (2006) who found significant associations across grades and gender. Specifically, these researchers found that moving from not-overweight to overweight across a four year span was significantly correlated with reductions in academic tests scores for girls in elementary school; however, this link was mostly absent for boys. While social-emotional functioning was not measured in the current study, it is possible that this variable could help explain why 5th grade girls appeared more adversely impacted academically by being overweight compared to other groups. For example, Faulkner and colleagues (2001) found that overweight adolescent females were more likely to report serious emotional problems and lower levels of self-efficacy than their normal weight peers. In addition, obese girls were about twice as likely to report being held back a grade and to consider themselves poor students. These patterns were not found in obese boys. It is possible that similar social-emotional issues existed in the sample of 5th grade girls included in the current study. Perhaps, the overweight 4th grade girls were just one-year away from encountering a similar fate as body image issues and related problems tend to emerge as children get older.

Implications

The data herein highlight the need for researchers to take a closer look at both individual and subgroup differences in the manifestation of poor academic performance associated with high BMI and low physical fitness. It seems that certain groups of children may be less susceptible to experiencing academic decline due to being overweight. For example, in this study overweight and physically unfit 4th grade students and 5th grade boys appeared impervious to declines in academic performance. This possibility should not be viewed as justification to devalue the importance of exercising as research indicates that regular exercise improves children's quality of life (Shoup, Gattshall, Dandamudi, & Estabrooks, 2008). However, data from the current study should caution readers to recognize that *not* all children will exhibit the same academic performance consequences due to being overweight and physically unfit.

Limitations

Several cautionary statements are warranted to dissuade readers from bypassing the limitations of this study. In addition there are unique characteristics of this study that should be considered when interpreting the results. First, the participants in this study attended the same school; thus, the population may be more homogenous than other groups included in similar investigations (e.g. Chomitz et al., 2009; Castelli et al., 2007; Grissom, 2005). Second, participants represented a narrow age range further limiting the generalizability of the findings. Third, the school that the participants attended may have better than average academic instruction and greater resources (e.g. teachers with terminal degrees, graduate student aides, interns) because it is a laboratory school affiliated with a large research oriented university. These resources could have helped prevent low achievement in at-risk children. Fourth, the school has an effectively implemented response-to-intervention (RTI) program which may meet the academic and social-emotional needs of at-risk students who would otherwise perform poorly on standardized academic achievement tests. RTI involves screening youth for problems, intervening early for at-risk youth, and monitoring students' response to the intervention as well as their general educational performance (Wodrich, Spencer, & Daely, 2006). Fifth, the students in this study attended a *choice school* which requires parents to autonomously apply for their child to attend. Generally, more assertive, concerned, and involved parents engage in this application process. Together, these characteristics may function as protective factors against negative academic outcomes. Another limitation of this study has to do with possible flaws in data collection. Although the PE teacher reportedly followed The President's Challenge guidelines, the researchers were not present to confirm this.

Conclusion

In view of the demands placed on schools to produce students who meet academic standards, understanding the relationship between weight status, physical fitness, and academic performance is crucial for quantifying the degree to which specific components of health affect learning and academic performance. Despite the limitations, the current study provides evidence that BMI and fitness were correlated with the academic performance for 5th grade girls. However, it will be important for future research to provide a more causal understanding of the relationship between BMI, physical fitness, and academic performance. As cross-sectional data, these results do not indicate causality. Based on this, these data do not infer that healthier BMI and higher fitness caused higher academic performance for 5th grade girls. Future research should examine children's social-emotional well-being to shed light on whether that aspect of a child's functioning mediates the relationship between BMI and academic performance. Finally, future research also should explore whether (and the extent to which) factors such as parental involvement, classroom instructional practices, and academic intervention programs (e.g. RTI) help overweight and physically unfit children become impervious to drops in academic performance.

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