Associations between Health-Related Physical Fitness, Academic Achievement and Selected Academic Behaviors of Elementary and Middle School Students in the State of Mississppi

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Abstract

A wide variety of school-based physical activity contexts have been recently associated with various measures of academic performance. Of these studies, a small number employing objective measures of student fitness have identified a relationship with academic achievements. However, even among these studies, the fitness-academic link has not been conclusively recognized or regularly assessed with regards to academic behaviors and socio-demographic variables. The purpose of this study was to explore the relationships among these variables by using objective measures of fitness, standardized Language Arts and Math test scores, attendance records, discipline actions, and socio-demographic information from a sample of 2,992 Mississippi (USA) public school children in grades 3-8. The sample consisted of students who were mostly male (52.4%), white (52.3%), in grades 3-5 (64.2%), within a healthy weight range (54.1%), and qualified for free/reduced price lunch (63.7%). The results indicated a statistically significant positive correlation between fitness and standardized test scores in Language Arts and Math and a statistically significant negative relationship with school absences. The relationships remained significant while controlling for gender, race, and socioeconomic status. Given that students who were more fit had higher test scores and fewer absences, these findings warrant consideration in the educational policy making process.

Key words: Exercise, Absenteeism, Standardized Tests

With an increasing focus on academic achievement and test scores, school administrators are constantly evaluating curricula to maximize learning opportunities. In order to decide whether to add, maintain, or cut physical activity and physical education (PE) programs in elementary and secondary schools, a growing number of researchers have attempted to explore the relationships between school-based physical activity contexts (e.g. physical education, recess, and other classroom and extracurricular physical activities) and students' academic performance (Centers for Disease Control and Prevention [CDC], 2010). While a number of studies have found that neither PE nor physical activity is harmful to academic performance (Dwyer, Coonan, Leitch, Hetzel, & Baghurst, 1983; Hervet, 1952; Sallis et al., 1999), findings are inconclusive as to whether either is actually helpful (Coe, Pivarnik, Womack, Reeves & Malina, 2006; Stevens, To, Stevenson, & Lochbaum, 2008). For example, Sallis et al. (1999) found that there was less of a decline in academic performance for students enrolled in PE compared to non-enrolled students, but no significant academic increases for enrolled students. Sheppard (1996) found that elementary school children, in particular, scored higher on achievement tests when they enrolled in additional physical education. To further complicate the results, one study found that girls received academic improvements with increased PE time, while boys did not (Carlson et al., 2008).

It is possible that the equivocal findings are due to the discrepancy in the amount of physical activity and PE among studies. For example, some researchers hypothesize that the inconsistencies in physical education instruction and curriculum and variations in the amount of time spent in moderate to vigorous activity during class may contribute to the discrepancies in the results (Coe et al., 2006; Dwyer, Sallis, Blizzard, Lazarus, & Dean, 2001; Stevens et al., 2008). In other words, simply a presence or a general amount of time one is present in PE may not actually be enough to gain significant improvements in health and fitness; therefore, measuring the amount of weekly physical activity or one's fitness status may be more informative in exploring the link to academic performance. Recent studies support these recommendations, as fitness levels and academic achievement have been shown to be more consistently linked (e.g., Castelli, Hillman, Buck, & Erwin, 2007; Chomitz et al., 2009; Eveland-Sayers, Farley, Fuller, Morgan, & Caputo, 2009; Kwak et al., 2009; Wittberg, Northrup, & Cottrel, 2009) compared with results in previous research using physical education or physical activity levels.

In examining the fitness-academic performance relationship, potential moderating variables include gender, race/ethnicity, and socioeconomic status (SES). With respect to gender, several studies have found differences in the fitness-academic performance relationship between boys and girls (Chomitz et al., 2009; Grissom, 2005; Kwak et al., 2009), but there are no specific patterns (CDC, 2010). In one study, girls demonstrated a stronger fitness-academic performance relationship than boys (Grissom, 2005), while in another study this gender difference was found only with English test scores (Chomitz et al., 2009). In addition, Kwak et al. (2009) identified vigorous physical activity to be the important link in the gender-fitness-academic performance relationship. Differences in psychological growth rates and motivational factors have been hypothesized to potentially explain the differences, as well as the idea that there is usually less variance in the amount of time boys spend participating in vigorous activity compared to girls (Kwak et al., 2009). As such, additional analysis of the moderating role of gender seems warranted.

Race/ethnicity and SES are additional demographic variables that may influence the fitness-academic performance relationship as they have been found to be independently linked to physical

activity (e.g. Singh, Kogan, Siahpush, & van Dyck, 2 009; Stevens et al., 2008; US Department of Health and Human Services [HHS], 2010) and standardized test scores (Chomitz et al., 2009; Tremblay, Inman, & Willms, 2000; Wittberg et al., 2009), but they have been rarely examined (CDC, 2010). For example, low SES Hispanic and black children have been found to be less active than higher SES white children due to the likelihood that the former may not have access to safe, outdoor play areas or afford to participate in formal team or individual sports (Evans & Kantrowitz, 2002; Frost, Wortham, & Reifel, 2005; Singh et al., 2009). These same racial and socio-economic groups of children have also been found to score lower in standardized tests, whereas a strong fitness-academic performance link for students from higher socioeconomic backgrounds has been reported (Chomitz et al., 2009; Grissom, 2005). Because of the strong potential for these socio-demographic variables to influence the fitness-academic performance relationship (Carlson et al., 2008; Grissom, 2005; Sigfusdóttir, Kristijansson, & Allegrante, 2007; Stevens et al., 2008; Wittberg et al., 2009), it appears that the moderating roles of SES and race/ethnicity need further analyses.

Academic behaviors, such as attendance and disciplinary actions, have also been found to be related to physical activity and fitness (e.g. Sigfusdóttir et al., 2007; Zeller & Modi, 2006). In a study with Icelandic high school children, a significant negative relationship was found between absenteeism and physical activity (Sigfusdóttir et al., 2007). Two other studies found a negative relationship between conduct scores and physical activity levels (Crist, 1995; Yu, Chan, Cheng, Sung, & Hau, 2006), but one of these studies identified the relationship for girls only (Yu et al., 2006). Given the limited body of research addressing confounding variables in the fitness-academic behavior link, more research is needed in this area.

In summary, literature is more consistently positive in the fitness-academic performance link when using an objective measure of fitness compared to the link between PE enrollment or self-reported activity levels and academic performance. However, there is still inconclusive evidence regarding the moderating influence of gender, race/ethnicity, and SES in the fitness-academic achievement link. Furthermore, the relationship between fitness and academic behaviors, such as attendance and disciplinary actions, and the moderating influence of gender, race/ethnicity and SES on this relationship have not regularly been considered. Therefore, the purpose of this study was to examine the relationships between fitness and both academic achievement and academic behavior, while controlling for gender, race/ethnicity, and SES. Two hypotheses formed this study. First, there would be significant positive relationships between fitness levels (i.e. number of healthy fitness zones achieved) and academic achievement (i.e. standardized test scores); second, there would be significant negative relationships between fitness levels and academic behaviors (i.e. absences and disciplinary actions).

Methods

Subjects

For this study, fitness data were collected from 6,022 Mississippi public school children in grades 3-8. Once the fitness data were matched by the Mississippi Department of Education (MDE) with student records within the Mississippi Student Information System (MSIS), a data set consisting of 3,398 students was produced. Of these matched records, a total of 351 did not include associated academic scores and/or behavior performance information and 55 records were duplicated. Hence, the final analysis included 2,992 records.

Instruments

Objective measures of fitness, academic achievement data on standardized test scores, academic behavior data on absences and disciplinary actions, and socio-demographic information of gender, race/ethnicity, and SES (via lunch status) based on the 2007-2008 academic year were obtained through MDE participating schools and the MDE's Office of MSIS. More information on each of these measures is described below.

Fitness. To objectively assess physical fitness, researchers used the *Fitnessgram*, which is a physical fitness test battery developed by the Cooper Institute (Cooper Institute for Aerobic Research, 2007). The test battery was used in tandem with the Physical Best curriculum developed by the National Association for Sport and Physical Education (NASPE), the latter being used as a guide for best practice for developing health-related physical fitness in the K-12 physical education setting. The *Fitnessgram* test battery provides suggested tests for six components of health-related fitness, PACER (Progressive Aerobic Cardiovascular Endurance Run), curl-up, push-up, trunk lift, sit and reach, and skinfold/Body Mass Index (BMI), with each fitness component having a healthy fitness zone. These healthy fitness zones are criterion-referenced standards and considered to be the minimal level of performance associated with good health or decreased risk (Welk & Meredith, 2008). Participants' overall fitness level was determined by the number of healthy fitness zones they achieved on the test battery, ranging from zero to six.

Academic achievement variables. The second version of the Mississippi Curriculum Test (MCT2) is administered annually to all Mississippi students in grades 3-8 in language arts and mathematics. The MCT2 has four levels of achievement, (a) minimal- students did not demonstrate mastery of the content area knowledge and skills required for success at the next grade, (b) basic- students demonstrated partial mastery of the content area knowledge and skills required for success at the next grade, (c) proficient– students demonstrated solid academic performance, and (d) advanced– students demonstrated academic performance clearly beyond the requirements to be successful at the next grade. For data analysis in the current study, students were grouped into either a low academic achievement group (students at minimal and basic levels) or a high academic achievement group (students at proficient and advanced levels).

Academic behavioral variables. MDE collects data on attendance and disciplinary actions on each student in K-12. Student absences are submitted to the school district daily and to MDE monthly. Average daily absence and individual absences are then input into the state database. For this study, absence was measured by the number of days students were absent and categorized into three groups: 0-3, 4-7, and 8 or more days missed during the academic year.

Disciplinary actions are reported similarly to absences;

infractions are tracked daily and reported monthly to the department of education. The percent of students with two or more disciplinary actions were very small, so actions that resulted in either In-School Suspensions or Out-of-School Suspensions were categorized into two groups: students with at least one reported suspension or those with no reported suspension.

Socio-demographic variable. Race/ethnicity were recorded and coded exactly as provided by the MDE. Based on whether or not students were qualified for free or reduced price lunch, three groups (free lunch, reduced price lunch, and paid lunch) were determined with SES.

Procedures

The study received Institutional Review Board approval through the Human Subjects Committee at the fourth author's institution. Due to the sensitive nature of using and merging student records, a Memorandum of Understanding (MOU) regarding the protection of the data was established between MDE and the fourth author. All data were handled electronically and once merged, were password protected.

In November 2007, 25 elementary and middle schools from across the state of Mississippi received funding from the Bower Foundation as part of the Health is Academic Quality Physical Education Program. As part of their funding, each school received the Physical Best Curriculum and the *Fitnessgram* software. In January 2008, each of the 25 schools sent three representatives to training sessions in which they received training on the implementation of Physical Best curriculum and the use of the *Fitnessgram* software by certified trainers. During the remaining months of the spring semester of 2008, 22 of the 25 schools were able to implement the curriculum in their PE classes; conduct the fitness tests; collect, record, and submit their data through the *Fitnessgram* software. Test administration was handled by the PE teachers at each school under the supervision of those receiving the training to ensure that the *Fitnessgram* would be administered in a consistent manner.

Data Treatment

The participating PE teachers input all demographic, bio-statistical, and fitness data into the Fitnessgram software as instructed in the training sessions and then exported the data directly from the software. All data files submitted by the schools were checked to determine if the required information was included. The researchers then created an Excel *Fitnessgram* template from the exported data to confirm that necessary variables had been properly recorded and reported.

Each case in the files included student name, date of birth, gender, grade level, and the six fitness test scores. Once the data submitted by the schools were in the correct format with all of the required information, fitness data were reformatted into ordinal scale as the overall fitness level based on the number of healthy fitness zones achieved. Once data were reformatted, all the participating schools' data were compiled into one file. This data file was submitted to the MDE's Office of Management Information Systems, and was then merged with student records within the MDE MSIS, which included student information regarding race/ethnicity, lunch status (free, reduced price, or paid lunch), academic achievement test scores (Language Arts and Math) and academic behavior (absences and suspensions).

Data Analysis

SAS 9.2 was used for all statistical analysis. Chi-square analyses were used to assess the statistical significance of observed differences in academic achievement and academic behaviors (i.e., absence and disciplinary actions) according to any selected characteristics. Multiple logistic regression models were used to identify factors associated with academic achievement and academic behaviors. Adjusted odds ratio (aOR) and 95%

Table 1. ***Sample Characteristics of Elementary and Middle School Students, Grades 3-8, Mississippi 2008***

Characteristic	Count	Percent
Gender		
Male	1567	52.4
Female	1425	47.6
Race		
White	1565	52.3
Black	1280	42.8
Other	147	4.9
Grade		
3rd	327	10.9
4th	799	26.7
5th	795	26.6
6th	309	10.3
7th	447	15.0
8th	312	10.4
Weight Status*		
Underweight	55	1.9
Healthy weight	1573	54.1
Overweight	521	17.9
Obesity	759	26.1
Lunch Status		
Free	1543	51.9
Reduced	349	11.8
Paid	1079	36.3
Absence		
0-3	1100	36.8
4-7	912	30.5
8+	980	32.8
Disciplinary Actions		
Yes	612	20.4
No	2380	79.6
Fitness Zones Achieved		
0	122	4.1
1	327	11.1
2	602	20.4
3	710	24.0
4	683	23.1
5	452	15.3
6	62	2.1
Language Arts		
High grade	1436	48.0
Low grade	1556	52.0
Math Grade		
High grade	1609	53.8
Low grade	1383	46.2

*Underweight - BMI < 5th percentile for age and gender; Healthy weight - BMI > 5th and <85th percentile for age and gender; Overweight - BMI > 85th and <95th percentile for age and gender; Obesity - BMI > 95th percentile for age and gender.

confidence interval (CIs) were obtained in each subgroup relative to a referent group while controlling for students' gender, race, lunch status, and the number of healthy fitness zones achieved. An aOR was considered statistically significant if its 95% CI did not include one (1.0). All reported p-values were two-sided.

Results

Students' Characteristics

The distribution of 2,992 students by selected characteristics is presented in Table 1. The gender composition of the participating schools (52.4% male vs. 47.6% female) was similar to that of the state (50.9% vs. 49.1%). The racial/ethnic composition of the sample (52.3% White, 42.8% Black, 4.9% Other) was somewhat different than that of the state (46.4% White, 50.6% Black, 3.0% Other). As for SES status, the percent of students who received free or reduced price lunch in the study sample (63.7%) was comparable to the rest of the state. The majority of students were within a healthy weight range (54.1%) and qualified for free or reduced price lunch (63.7%). Also, 48.0% and 53.8% of the participants achieved high performance in Language Arts and Math, respectively. Nearly one-third (32.8%) of the participants were absent eight or more times and about one fifth (20.4%) received one or more disciplinary actions.

Academic Achievement

Students' academic achievement differed significantly by gender, race/ethnicity, SES, and the number of healthy fitness zones achieved (see Table 2). Females and white students tended to demonstrate high achievement. High achievement was also demonstrated by students with high SES status (i.e. not receiving free or reduced price lunch) and those with a higher number of healthy fitness zones achieved. Additionally, all factors (i.e. gender, race, SES, and number of healthy fitness zones achieved) were significant predictors of high academic achievement (see Table 3). Specifically, girls had about 23-29% increased odds to achieve higher academic achievement than boys. White students and students identified in "other" races were approximately twice as likely to demonstrate high academic achievement as Black students. Students with high SES were approximately more than 2.5 times as likely to obtain high academic achievement as those with low SES. In addition, a significant linear trend ($p < 0.0001$) was observed between academic achievement and overall fitness level, indicating the odds of high academic achievement increased with the number of healthy fitness zones achieved (see Figure 1).

Academic Behavior

For academic behavior, students with eight or more absences differed significantly by race/ethnicity, SES, and the number of

Table 2. ***High MCT2 Scores and Academic Performance by Selected Factors, Grades 3-8, Mississippi, 2008***

	High Achievement in Language Arts			High Achievement in Math			Had 8+ Absences			1+ Disciplinary Actions		
	n	%	p-value	n	%	p-value	n	%	p-value	n	%	p-value
Total	1436	48.0		1609	53.8		980	32.8		612	20.5	
Gender			0.0125			0.0338			0.8918			< 0.0001
Male	718	45.8		814	52.0		515	32.9		419	26.7	
Female	718	50.4		795	55.8		465	32.6		193	13.5	
Race			< 0.0001			< 0.0001			< 0.0001			< 0.0001
White	933	59.6		1020	65.2		617	39.4		200	12.8	
Black	428	33.4		503	39.3		311	24.3		389	30.4	
Other	75	51.0		86	58.5		52	35.4		23	15.7	
Grade			0.0013			< 0.0001			0.7293			< 0.0001
3rd	176	53.8		212	64.8		113	34.6		20	6.1	
4th	416	52.1		468	58.6		246	30.8		126	15.8	
5th	374	47.0		393	49.4		269	33.8		168	21.1	
6th	137	44.3		164	53.1		97	31.4		98	31.7	
7th	208	46.5		256	57.3		150	33.6		108	24.1	
8th	125	40.1		116	37.2		105	33.7		91	29.2	
Lunch Status			< 0.0001			< 0.0001			0.0069			< 0.0001
Free	541	35.1		645	41.8		545	35.3		433	28.1	
Reduced	180	51.6		192	55.0		109	31.2		70	20.1	
Paid	702	65.1		761	70.5		319	29.6		105	9.7	
Fitness Zones Achieved			< 0.0001			< 0.0001			0.0089			0.2154
0	43	35.3		53	43.4		48	39.3		27	22.1	
1	138	42.2		157	48.0		109	33.3		79	24.2	
2	263	43.7		294	48.8		213	35.4		112	18.6	
3	357	50.3		385	54.2		235	33.1		157	22.1	
4	331	48.5		381	55.8		216	31.6		123	18.0	
5	247	54.7		276	61.1		137	30.3		95	21.0	
6	41	66.1		47	75.8		8	12.9		11	17.7	

Table 3. ***Adjusted Odds Ratios for Academic Achievement, Grades 3-8, Mississippi, 2008***

	High Achievement in Language Arts			High Achievement in Math		
Characteristic	Odds ratio[a]	95% CI[b]	p-value	Odds ratio[a]	95% CI[b]	p-value
Gender			0.0012			0.0085
Male	1.00	(referent)		1.00	(referent)	
Female	1.29	(1.11-1.51)		1.23	(1.06-1.44)	
Race			< 0.0001			< 0.0001
White	2.10	(1.76-2.51)		1.96	(1.65-2.34)	
Black	1.00	(referent)		1.00	(referent)	
Other	1.97	(1.38-2.82)		2.06	(1.43-2.95)	
Grade			0.7069			< 0.0001
3rd	0.99	(0.70-1.40)		1.94	(1.37-2.76)	
4th	1.08	(0.81-1.45)		1.68	(1.26-2.26)	
5th	0.96	(0.71-1.28)		1.24	(0.92-1.66)	
6th	0.94	(0.66-1.32)		1.61	(1.14-2.27)	
7th	1.13	(0.82-1.55)		2.10	(1.53-2.88)	
8th	1.00	(referent)		1.00	(referent)	
Lunch Status			< 0.0001			< 0.0001
Free	1.00	(referent)		1.00	(referent)	
Reduced	1.76	(1.38-2.24)		1.51	(1.18-1.93)	
Paid	2.59	(2.16-3.10)		2.53	((2.10-3.04)	
Fitness Zones Achieved			0.0001			< 0.0001
0	1.00	(referent)		1.00	(referent)	
1	1.31	(0.83-2.07)		1.25	(0.80-1.95)	
2	1.33	(0.87-2.04)		1.21	(0.80-1.84)	
3	1.78	(1.16-2.71)		1.54	(1.02-2.33)	
4	1.60	(1.05-2.45)		1.62	(1.07-2.46)	
5	2.09	(1.35-3.25)		2.01	(1.31-3.11)	
6	3.31	(1.66-6.57)		4.14	(2.01-8.55)	

[a] Odds ratios were adjusted for all selected characteristics.
[b] 95% confidence intervals.

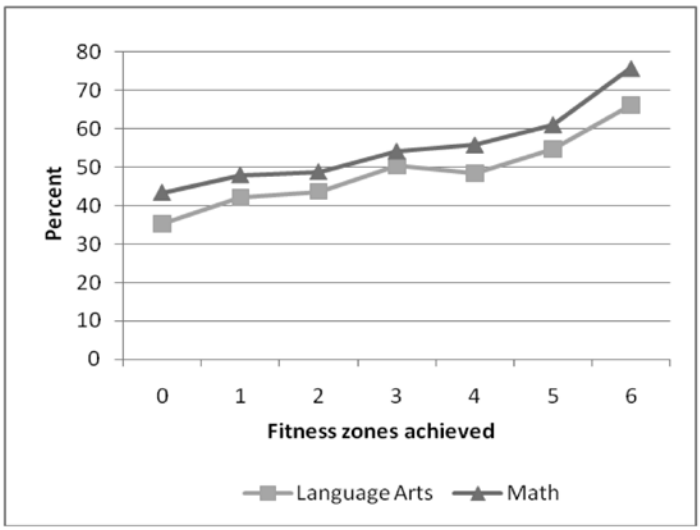

Figure 1. Percent of Students with High Academic Achievement in Standardized Test Scores, Grades 3-8, Mississippi, 2008

healthy fitness zones achieved (see Table 2). White students, students who qualify for free or reduced price lunch, and students with less healthy fitness zones achieved tended to have more

Table 4. ***Adjusted Odds Ratios for Academic Behaviors, Grades 3-8, Mississippi, 2008***

	Had 8+ Absences			1+ Disciplinary Actions		
Characteristic	Odds ratio[a]	95% CI[b]	p-value	Odds ratio	95% CI	p-value
Gender			0.936			< 0.0001
Male	0.99	(0.85-1.17)		2.53	(2.07-3.09)	
Female	1.00	(referent)		1.00	(referent)	
Race		< 0.0001				< 0.0001
White	1.00	(referent)		1.00	(referent)	
Black	0.34	(0.28-0.41)		2.03	(1.62-2.53)	
Other	0.64	(0.44-0.92)		0.89	(0.55-1.46)	
Grade			0.1296			< 0.0001
3rd	1.00	(referent)		1.00	(referent)	
4th	1.01	(0.76-1.34)		2.35	(1.42-3.90)	
5th	1.14	(0.85-1.51)		3.27	(1.99-5.39)	
6th	0.96	(0.68-1.35)		5.54	(3.26-9.42)	
7th	1.25	(0.91-1.72)		3.53	(2.10-5.94)	
8th	1.44	(1.01-2.04)		3.96	(2.31-6.78)	
Lunch Status			< 0.0001			< 0.0001
Free	2.08	(1.71-2.53)		2.63	(2.03-3.40)	
Reduced	1.35	(1.03-1.78)		1.89	(1.34-2.68)	
Paid	1.00	(referent)		1.00	(referent)	
Fitness Zones Achieved			0.0093			0.4840
0	4.45	(1.92-10.36)		1.07	(0.47-2.44)	
1	3.78	(1.71-8.35)		1.37	(0.65-2.88)	
2	4.21	(1.94-9.15)		0.99	(0.48-2.04)	
3	3.85	(1.77-8.35)		1.25	(0.61-2.57)	
4	3.39	(1.56-7.38)		1.07	(0.52-2.21)	
5	3.31	(1.51-7.28)		1.27	(0.61-2.66)	
6	1.00	(referent)		1.00	(referent)	

[a] Odds ratios were adjusted for all selected characteristics.
[b] 95% confidence intervals.

absences. Students with one (1) or more disciplinary actions differed significantly by gender, race/ethnicity, and SES except for the number of healthy fitness zones achieved. Boys, Black students, and those qualifying for free or reduced price lunch status tended to receive more disciplinary actions.

Furthermore, White students, students with low SES, and those with less healthy fitness zones achieved were more likely to be absent eight or more times than their counterparts (see Table 4). Similar to absenteeism, students with low SES were more than twice as likely to have disciplinary actions. Gender was not statistically associated with absenteeism while the number of healthy fitness zones achieved was not statistically associated with disciplinary actions.

Discussion

Results from this study indicated that students who were more fit were less likely to miss school and do poorly on standardized tests, which are two key risk factors often associated with dropping out of school (America's Promise Alliance, 2006). With this information, school administrators may be able to feel more confident about dedicating time during the school day for both physical education and physical activity, especially when fitness is emphasized, in order to promote students' overall academic

success. School administrators can work with physical education teachers and school health coordinators to incorporate more fitness activities into the curriculum and school programs in an effort to meet the NASPE's physical activity recommendations, while providing students with balanced academic opportunities (CDC, 2010).

Furthermore, in the current study when gender, race/ethnicity, and SES were controlled, significant positive relationships still existed between fitness levels (i.e. number of healthy fitness zones achieved) and standardized test scores in both Language Arts and Math. For Language Arts, the likelihood of high academic achievement increased with each additional fitness zone achieved (up to three times); for Math, a similar trend was found. For example, students with the highest number of healthy fitness zones achieved were approximately three to four times more likely to have high levels of academic achievement (high test scores) compared to those with zero healthy fitness zone achieved. The findings are similar to Chomitz et al. (2009), who found the odds of passing a standardized math test increased by 38% and 24% for English with each additional fitness test passed at the healthy fitness zone level.

While causal inferences or physiological explanations for the fitness-academic link cannot be derived from this study, other research has shown that physical activity can increase cognitive functioning in reaction time and response accuracy as well as students' ability to concentrate (Hillman, Buck, & Themanson, 2009). Much of the research to date has focused on these topics with adult participants; however, a meta-analysis revealed that the cognitive benefits of physical activity seem to be of particular benefit for elementary and middle school students (Sibley & Etnier, 2003). If the implications from these findings are emphasized for this age group, there may be long-term benefits as children make exercise behaviors habitual. The result of such a scenario would be children with their physical needs met and their cognitive abilities enhanced, setting up the students for productive learning at later stages in their academic careers.

Findings from this study also address the relationship between fitness and academic behaviors, such as absenteeism and disciplinary actions. For absences, the results indicated a significant negative relationship with the number of healthy fitness zones achieved. Students with the lowest number of healthy fitness zones were over four times more likely to have eight or more absences for the academic year compared with students who achieved the highest number of healthy fitness zones. This finding is similar to that of Sigfusdóttir et al. (2007), who found a significant negative relationship between absenteeism and physical activity in Icelandic children. While there are only a few studies exploring this relationship in children, there is a fairly clear link between poor fitness levels and missed work in adults (Kyröläinen et al., 2008). Furthermore, research suggests that individuals who are more physically fit may be able to better combat stress (Crews & Landers, 1987). In learning from the research with adults, the findings of this study might be explained best by the idea that fit students are overall healthier or better equipped physiologically to cope with physical and psychological stress compared to unfit students; therefore they are less likely to miss school.

Contrary to one of this study's hypotheses, the relationship between fitness and disciplinary actions was not statistically significant. For the variable of disciplinary actions, students were grouped based on whether they had been reported for zero suspension or for one or more suspensions. This grouping method may not be an ideal one for exploring such academic behaviors because in-school and out-of-school suspensions typically are warranted only when significant behavioral problems happen. Less serious classroom behavior problems were not accounted for by the model employed in this study. Other studies have used tardiness or conduct scores, which were found to be negatively related to physical activity levels (e.g. Crist, 1995; Yu et al., 2006).

While the results of this study support and further clarify the current understanding of the fitness-academic performance link, the study is not without limitations. This study employed a cross-sectional design targeting students in schools that had received funding for a PE curriculum and equipment; the study was not able to operate from a predictive model with the sample used. With 22 of those 25 funded schools participating in this study, there is the risk of a potential self-selection bias. As such, the findings from students attending these schools cannot be generalized to all students in all public schools. Additionally, while this study further establishes a link between fitness and academic performance, it was difficult to provide an explanation for the relationship due to the lack of an underlying mechanism and the epidemiological approach of the study.

In moving forward, researchers may want to explore the opportunity for longitudinal studies with cohort groups. This could be expanded to compare cohort groups of students who receive different PE curricula or physical activity requirements. Within future studies, researchers would also further the literature by exploring differences in the fitness-academic performance link by specific fitness components (i.e., aerobic capacity, flexibility, strength and endurance). Additionally, researchers can use these results to justify additional research on exercise programming to determine which types of activities would be most efficient at helping students become fit.

These findings suggest that a good investment in the future of public education may be through an investment in student fitness, because these findings, along with other studies, indicate that the link with academic performance is based on fitness, not just presence in a PE class or other opportunities to be physically active. Policy makers can use this research to help justify participation in, and resources for, activities that have been shown to improve children's fitness levels. Implementation of PE curricula that allows for more time spent on fitness development and improvement may be a more effective tool than merely requiring a certain number of minutes in physical education per week.

These findings also suggest a need to consider not only more fitness in the PE curricula, but also implementing a wider use of the fitness testing of all students in all grades. For example, currently in Mississippi, fitness testing is only required of students in 5th and 9th grades. As such, it is less likely that schools emphasize fitness in other grades. Consequently, this lessens the likelihood for students to have opportunities to work toward, achieve, or maintain fitness and a fitness-oriented lifestyle.

Expanding fitness and fitness testing in PE will likely require more education for PE teachers on the principles of fitness, perhaps

even a fitness certification. This suggests the implications would affect not only colleges and universities in preparation of PE teachers, but also schools needing PE teachers certified to teach and assess fitness. If schools do not have the resources to incorporate strong fitness components, they may need to develop partnerships with fitness facilities such as a local YMCA, or other organizations that may have individuals with fitness expertise. Such a partnership would help school districts develop a trained fitness testing team to assist their personnel accurately and efficiently assess the students. Additionally, it would provide qualified personnel to lead staff and faculty in-trainings on the subject.

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