EXERCISE SCIENCE

The Relationship Among Aerobic Capacity, Body Composition, and Academic Achievement of Fourth and Fifth Grade Hispanic Students

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Abstract

Research has shown positive relationships between academic achievement and both physical activity and physical fitness. However, none of this research has focused on students from Hispanic backgrounds. Therefore, it is important to investigate the contributions of health-related fitness measures on Hispanic students' academic performance. The purpose of the study was to examine the relationship of aerobic capacity and body composition with academic achievement in Hispanic elementary school children. Participants in the study were 155 Hispanic school children (84 boys and 71 girls), aged 9 to 13, in the fourth and fifth grade at an urban elementary school in southeast Texas. Health-related fitness measures included aerobic capacity, body mass index, and percent body fat. Academic achievement variables included reading and math final percentage grades. Correlations and stepwise multiple

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regression analyses were performed to analyze the relationship between the variables. Analyses were conducted on the whole sample and by gender. Pearson correlations revealed a significant positive relationship (r = .26, p = .022) between aerobic capacity and math performance for girls. Stepwise multiple linear regression analysis also revealed that aerobic capacity was a significant predictor of math performance in girls, F(1, 69) = 6.15, and yielded the following equation to predict the math grade: MATH = (78.03) + (.26) (AC); R2 = .08; adjusted R^2 = .06, SEE = 7.31; p = .016. These findings suggest that aerobic capacity positively effects math performance in fourth and fifth grade Hispanic elementary school girls.

A variety of health benefits are associated with physical activity (PA) including reduced risk of cardiovascular disease, diabetes, some cancers, and obesity and enhanced self-esteem and overall psychological well-being (U.S. Department of Health and Human Services [USDHHS], 1996; Vincent & Pangrazi, 2002). Numerous researchers have examined the relationship of academic achievement with PA and fitness among school-aged children. A significant amount of this research has indicated a positive relationship between academic achievement and PA and fitness in school-aged children (Buck, Hillman, & Castelli, 2008; Castelli, Hillman, Buck, & Erwin, 2007; Coe, Pivarnik, Womack, Reeves, & Malina, 2006; Welk et al., 2010; Wittberg, Cottrell, Davis, & Northrup, 2010). Scholars have suggested that improvements in academic achievement as a result of increased PA may be due to the following: (a) increased arousal and reduced boredom, which may result in increased attention span and concentration (Coe et al., 2006), and (b) increased self-esteem, which may lead to improvements in on-task classroom behavior (Shephard, 1996). Furthermore, recent research has addressed different frameworks that work to explain the relationship between PA and cognitive performance (Etnier & Landers, 1995; Tomporowski, 2003; Travlos, 2010). Specifically, physiological responses to regular PA include "increased cerebral blood flow, changes in hormone levels, greater arousal and stimulation, alterations in brain neurotransmitter activity, and improved nutrient intake" (Eveland-Sayers, Farley, Fuller, Morgan, & Caputo, 2009, p. 103), all of which have been associated with enhanced academic performance.

Despite these meaningful findings, it is important to recognize that some researchers have indicated a weak link between PA and academic achievement (Daley & Ryan, 2000; Martin & Chalmers, 2007; Tremblay, Inman, & Willms, 2000). Tremblay et al. (2000) examined the relationship among PA, self-esteem, and academic achievement among 12-year-old children and found that PA had a positive relationship with self-esteem and a weak relationship with academic achievement. Also in 2000, Daley and Ryan found no significant relationship between academic performance and participation in PA among secondary school adolescents. In 2007, Martin and Chalmers examined the relationship between academic achievement and physical fitness among students in grades 3, 5, 6, and 8. Their findings indicated that the relationship between academic achievement and physical fitness "is of little practical importance" (p. 214). Martins and Chalmers further argued, "Physical education programs should not be advocated as a means to promote academic achievement in students" (p. 214).

The No Child Left Behind (NCLB) Act, introduced by President George W. Bush in 2001 and adopted by Congress in early 2002, places added emphasis on core subjects such as reading and math, linking federal funds to the results of standardized tests in those subjects. In the wake of NCLB, educators lamented the need to "teach to the test" and administrators dedicated additional class time to ensure their schools met the requirements and avoided being labeled *failing schools*. As a result, time devoted to electives such as art, music, and physical education plummeted (Center on Education Policy, 2007). One of the major reasons school teachers and administrators cited for cutting PA and physical education programs was they "take time away from the classroom desk" (Wittberg et al., 2010, p. 285). The Center on Education Policy (2007) reported that 62% of school districts have increased instructional time for English Language Arts (ELA) and/or math in elementary schools since the inception of NCLB. To accommodate for this increased time in ELA and math, approximately 44% of school districts reduced time from one or more subject or activities (e.g., physical education, recess; Center on Education Policy, 2007). Lee, Burgeson, Fulton, and Spain (2007) reported that only 3.8% of elementary schools, 7.9% of middle schools, and 2.1% of high schools offered students daily physical education or equivalent. Despite this trend, no clear evidence indicates that academic achievement will improve if

physical education classes are eliminated (Coe et al., 2006; Trost & van der Mars, 2009). It also ignores the potential benefits of PA on academic performance (Trost & van der Mars, 2009). Furthermore, this trend raises public health concerns as the nation's schools have been identified to play a major role in the fight against childhood obesity and physical inactivity (Fairclough & Stratton, 2005; Trudeau & Shephard, 2005).

Whereas research supports the positive association between academic achievement and physical fitness, little is known about this relationship in children from Hispanic backgrounds. Hispanics represent the largest minority group in the United States and the fastest growing segment of the school-aged population (National Center for Education Statistics [NCES], 2007). Despite the numerous physical and psychological benefits associated with regular PA, inactivity rates for Hispanics have been reported to be the highest among all ethnic and racial groups, independent of social class (Crespo, 2005; Crespo, Smith, Andersen, Carter-Pokras, & Ainsworth, 2000; Marquez & McAuley, 2006). In addition, Sanders and Duncan (2006) indicated that cardiovascular fitness among Hispanics is low. Significant documentation has attested to the high rates of obesity, physical inactivity, and type 2 diabetes in Hispanic children and youth (Crespo, 2005). According to the Centers for Disease Control and Prevention (CDC, 2002), Latin students are significantly less likely to participate in organized PA and significantly less likely to report moderate-to-vigorous PA compared to their Caucasian counterparts. In 2006, Ogden et al. suggested approximately 37% of Mexican American children and adolescents aged 2 to 19 are classified "at risk of overweight" or "overweight." In another study in the Texas schools, fourth grade Hispanic boys and girls showed the highest prevalence of overweight when compared with African American and Caucasian children (Hoelscher et al., 2004). Physical inactivity has also been found to be especially high among Latinas (Crespo, 2005). Denner and Dunbar (2004) examined the ways in which Mexican girls negotiated their femininity and found that they perceived PA was inappropriate for girls. More recently, Oliver, Hamzeh, and McCaughtry (2009) and Oliver and Hamzeh (2010) examined the self-identified barriers to PA among fifth grade Latinas. Barriers for Latinas included (a) boys' negative actions and words toward physically active girls, (b) a lack of equipment and space for girls (because boys were using the equipment and occupying

the playground), (c) family obligations, (d) school officials ignoring girls' physical inactivity, (e) a lack of encouragement from family members for girls to be physically active, and (f) being a "girly girl" (e.g., did not want to sweat or mess up their nails or hair and wore inappropriate clothing for being physically active).

With regard to academic performance, Hispanic students lag behind when compared to other racial/ethnic groups. Research has found that Hispanic students aged 9, 13, and 17 consistently perform below some of their racial/ethnic peers in the National Assessment of Educational Progress (National Center for Education Statistics, 2003). In the three age categories (9, 13, and 17), Hispanic students lag behind their Caucasian peers in reading and in math.

Socioeconomic status also plays an integral role in academic achievement. Research has indicated that approximately 27% of Hispanic children enrolled in public schools come from families with incomes below the poverty level and that 33% are near poor (Center on Education Policy, 2010). Hispanic children are twice as likely to be poor as Caucasian children (Berliner, 2009). Furthermore, one third of Hispanic families have no health insurance and rarely see necessary health professionals (e.g., optometrists, dentists, or doctors). As a result, many Hispanic children attend school with vision problems and untreated health problems, and many also go to school hungry. As Gándara (2010) suggested, "These all constitute serious impediments to learning that schools are often poorly equipped to address" (p. 26).

It is also important to examine the structure of the Hispanic family and the emphasis placed on education. Hispanic families are significantly more likely to come from homes in which parents speak very little English. Furthermore, research has indicated a strong relationship between parents' educational attainment and student achievement (Davis-Kean, 2005). In many Hispanic families, parents' education levels are also low with approximately 40% of Hispanic mothers without a high school diploma. Only 10% of Hispanics in the United States have a college degree. These limited educational resources available in the homelife present numerous challenges for young learners.

Although researchers have found a positive relationship between academic achievement and both PA and physical fitness, the majority of research has focused on Caucasian populations, which may not translate well to other racial/ethnic groups (Wittberg et al., 2010).

As Trost and van der Mars (2009) suggested, "We know little about the effect of in-school PE on academic performance among students at the highest risk for obesity, including low income children from African American, Latino, American Indian, and Pacific Islander backgrounds" (p. 63). In addition, much of the research has focused on already high-achieving, affluent school districts. Therefore, the purpose of this study was to address this paucity in the academic literature by examining the relationships of aerobic capacity and body composition with academic achievement of Hispanic elementary school children.

Methods

Participants

The participants consisted of 155 (boys = 84, girls = 71) fifth and fourth grade Hispanic students aged 9 to 13 from an urban school located in southeast Texas. One hundred eight students were enrolled in fifth grade and 57 in fourth grade. Consent from parents was secured according to established district guidelines, and the corresponding institutional review boards approved the procedures.

School Characteristics

The participants were recruited from an elementary school in a major metropolitan area in southeast Texas. According to the Texas Education Agency (TEA, 2012), the total school enrollment was 982 students of which 49% were girls and 51% were boys. The racial/ethnicity composition of the school was 9% African American, 3% Asian/Pacific Islander, 86% Hispanic, and 1% Caucasian. Ninety-nine percent of the students in the school qualified for the free/reduced lunch program, 83% were considered limited English proficient, and 92% were considered *at risk*. The U.S. Department of Education (2010) defines a student as at risk when he/she (a) is at risk of academic failure, (b) has a drug or alcohol problem, (c) is pregnant or is a parent, (d) has come into contact with the juvenile justice system in the past, (e) is at least one year behind the expected grade level for the age of the individual, (f) has limited English proficiency, (g) is a gang member, or (h) has dropped out of school in the past or has a high absenteeism rate. The school met adequate yearly progress and was considered "academically acceptable" by the TEA accountability rating system.

Data Collection Procedures

Health-related fitness measures. Health-related fitness includes the components of physical fitness that serve to achieve and maintain good health (Corbin, Pangrazi, & Franks, 2000). The components of health-related fitness include aerobic capacity (AC), muscular strength and endurance, body composition, and flexibility. For the purpose of this study, AC and body composition were measured. Researchers have suggested that "AC is perhaps the most important area of any fitness program" as it is "clearly associated with a reduced risk of high blood pressure, coronary heart disease, obesity, diabetes, some forms of cancer and other health problems" (The Cooper Institute, 2007, p. 27). The participants were measured on AC and body composition at the end of the 2006 academic school year. Measures were conducted in the school gymnasium by a certified and trained physical education teacher as part of the physical education class.

Following procedures established in the *FITNESSGRAM® Test Administration Manual* (The Cooper Institute, 2007), the physical education teacher measured AC using the Progressive Aerobic Cardiovascular Endurance Run (PACER). The PACER is a 20-m shuttle run that progressively increases in difficulty. The physical educator recorded the number of laps completed in the PACER when the students could no longer maintain the specified pace or did not reach the line for the second time before the beep sound. This number served as each participant's score. Body composition was assessed using two methods: (a) percent body fat (%BF) and (b) body mass index (BMI). Percent body fat was assessed by measuring the triceps and calf skinfolds using a Lange Skinfold Caliper and by following the procedures established in the *FITNESSGRAM® Test Administration Manual* (The Cooper Institute, 2007). Three measures were taken at each site with the median used for analysis. Percent body fat was estimated using the Slaughter and Lohman equation (Slaughter et al., 1988). BMI was calculated using weight and height measures. Weight was measured to the nearest half pound using a Health-o-meter professional physician scale (model #402LB). Per standardized protocols, height was measured in inches using a stadiometer. These measures were converted to standard units to calculate BMI (kg/m^2).

Academic achievement. Researchers have suggested that overall grades are an indicator of academic performance "because

students and parents regularly monitor student performances via grades" (Kao & Thompson, 2003, p. 421). For the purpose of this study, academic achievement was based on reading (READ) and math final percentage classroom grades. Upon receiving permission from the school principal, we obtained final percentage grades from the school database.

Data Analysis

Descriptive statistics were calculated for all health-related fitness measures and academic achievement variables across the sample. Pearson product–moment correlations coefficient and stepwise multiple regression analyses were performed to analyze the relationship between academic achievement and health-related fitness measures. All statistical analyses were conducted with the combined sample and by gender. All data analyses were performed using SPSS version 17.0 (SPSS Inc., Chicago, IL). The alpha level was set at .05 level of significance.

Results

Descriptive statistics for all variables are shown in Table 1. To evaluate the relationship between academic achievement and health-related fitness measures, Pearson product–moment correlations coefficient were run for the combined sample and by gender. The Pearson correlation analysis revealed no significant relationship between health-related fitness measures and academic achievement variables for the combined sample. Correlation analyses indicated that math was correlated with AC (r = .14, p = .072), with %BF (r = -.03, p = .689), and with BMI (r = -.07, p = .421). Reading was correlated with AC (r = .01, p = .881), with %BF (r =.002, p = .980), and with BMI (r = -.06, p = .421). Because none of these correlations were significant, the correlation analysis was performed by gender. AC showed a significant positive relationship (r = .26, p = .022) with math performance in girls. Table 2 presents the results of the correlation analysis by gender.

A stepwise regression analysis was performed to determine if any of the health-related fitness measures could be used to predict academic achievement. The analysis revealed that AC, %BF, and BMI were not significant predictors of academic achievement (READ, MATH) when used with the combined sample. When the regression was conducted by gender in the case of reading, the results did not reveal a significant relationship, indicating that AC, %BF,

Table 1

Descriptive Statistics of Health-Related Fitness Measures and Academic Achievement

	Girls			Boys			Total		
Variables	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Age (years)	74	10.5	.7	89	10.9	.7	163	10.7	.7
Height (m)	75	1.4	.08	88	1.4	.09	163	1.4	.09
Weight (kg)	76	42.5	12.6	89	44.5	12.5	165	43.6	12.6
MATH	76	82.4	7.8	89	81.8	7.9	165	82.1	7.9
READ	76	83.0	7.4	89	80.4	6.8	165	81.6	7.2
%BF	76	24.9	7.3	89	25.2	10.0	165	25.1	8.8
BMI	75	19.3	4.4	88	20.2	4.3	163	19.8	4.3
AC	72	17.0	8.1	85	24.6	13.2	157	21.1	11.7

Note. %BF = percent body fat; BMI = body mass index; AC = Aerobic Capacity

Table 2

Correlation Coefficients Between Health-Related Fitness Measures and Academic Achievement for Gender

Variables	1	2	3	4	5
Girls					
1. MATH	--				
2. READ	.82**	--			
3. %BF	.02	.03	--		
4. BMI	-.02	-.01	.90**	--	
5. AC	.26*	.16	-.40**	-.37**	--
Boys					
1. MATH	--				
2. READ	.83**	--			
3. %BF	-.06	-.01	--		
4. BMI	-.11	-.07	.89**	--	
5. AC	.11	.02	-.50**	-.38**	--

Note. %BF = percent body fat; BMI = body mass index; AC = Aerobic Capacity
*$p < .05$, **$p < .01$

and BMI were unrelated to reading percentage grade. However, AC was found to be a significant predictor of math performance in girls, $F(1, 69) = 6.15$, and yielded the following equation to predict the math percentage grade, MATH = (78.03) + (.26) (AC); $R^2 = .08$; $SEE = 7.31$; $p = .016$, indicating that higher aerobic capacity was associated with higher math percentage grade.

Discussion

This study examined the relationship of aerobic capacity and body composition with academic achievement of fourth and fifth grade Hispanic students from an urban school located in southeast Texas. We hypothesized AC and body composition would positively relate to reading and math percentage grades. The results of the study did not find that AC and body composition significantly related to academic achievement for the combined group of boys and girls. However, when the analysis was conducted by gender, the results revealed a small but positive significant relationship between AC and overall math grades among the girls. These results are consistent with Wittberg, Cottrel, Davis, and Northrup (2010) who reported a significant positive relationship ($r = .16$, $p < .001$) between PACER test scores and scores in math in primarily Caucasian fifth grade girls. In 2009, Eveland-Sayers et al. also found that higher levels of AC in third, fourth, and fifth grade girls were positively related to higher scores in standardized math and reading tests.

The findings of the present study suggest that girls with higher AC may show higher achievements in math. Previous research has also suggested a stronger relationship between physical fitness and academic achievement among girls compared to boys (Dwyer, Sallis, Blizzard, Lazarus, & Dean, 2001; Grissom, 2005; Wittberg, Cottrel, Davis, & Northrup, 2010). Carlson et al. (2008) conducted a longitudinal study examining participation in physical education and academic achievement in children enrolled in kindergarten to fifth grade. Girls that participated in physical education more minutes per week scored higher in academic achievement, whereas boys with greater exposure to PA were neither positively nor negatively associated with academic achievement. Wittberg et al. (2010) suggested that such gender differences "may be due to social, physiological, or some other reason that is not known" (p. 286). Little discussion of these factors has been addressed in the literature.

The CDC (2002) reports that girls are significantly less likely than boys to have recently participated in moderate-to-vigorous

PA, met currently recommended levels of PA, or attended physical education classes. Physical inactivity has also been found to be especially high among minority girls, Latinas in particular (Crespo, 2005). Research suggests that inactivity among girls likely occurs because girls typically report more barriers to PA participation than boys (The Tucker Center for Research on Girls & Women in Sport, 2007). Social and cultural norms have been found to play a strong role in dictating what young girls perceive is appropriate for females (Denner & Dunbar, 2004). Girls learn early that they should take up less space and refrain from overly physical acts or run the risk of being perceived as less "feminine." Researchers have found that such standards are especially embedded into Latin and Hispanic families, which tend to ignore girls' inactivity and place greater emphasis on their responsibilities at home.

Even within the school system, the inactivity of Latin girls has been ignored (Oliver & Hamzeh, 2010; Oliver et al., 2009). Given the findings of the present study, it is possible that because of the limited experiences and opportunities girls have for PA, both in and outside of school, when they are active, the benefits are slightly greater than those of boys who engage in PA on a regular basis. Such an argument may explain why girls have been found to score higher on academic achievement than boys when afforded an opportunity to engage in PA. However, such an argument should not be used to discourage boys' involvement in physical education classes. Further research is needed to examine more closely the factors that may contribute to such findings. Furthermore, based upon the findings from the present study, it is especially important that community organizations and parents of young girls, minority girls in particular, are educated on the importance of PA for girls. Such conversations must explore ways in which to encourage PA among girls in and outside of school. Another possible explanation may be related to the intensity and work rate of the girls compared to the boys on the PACER test. The boys may not have been working at a high enough physiological threshold to improve cognitive performance.

The demographic makeup of the participants is especially important to discuss in relation to the present findings. All participants were recruited from an urban, inner-city elementary school. Ninety-nine percent of the students at this school qualified for the free/reduced lunch program, 83% were considered limited English proficient, and 92% were considered at risk (TEA, 2012). Research

has suggested that socioeconomic status (SES) has a significant impact on academic performance; poor and low SES children have been found, on average, to perform significantly less well than non-poor and middle-class children on numerous indicators of academic achievement (Gándara, 2010). Furthermore, schools in low SES communities are the primary focus of the NCLB law, which places more emphasis on ELA and math rather than physical education/PA. However, the findings from the present study indicate that increased AC may academically benefit girls from a low income, urban community, challenging the perception that physical education/PA takes time away from "important" subjects.

In addition to the potential academic benefits of PA and health-related fitness, it is also important to acknowledge the health benefits associated with PA among the population being studied. As previously noted, physical inactivity rates for Hispanics have been reported to be highest among all ethnic and racial groups (Crespo, 2005). Activity levels decrease even further among Hispanic girls (Crespo, 2005). As a result, physical inactivity is a serious public health issue facing Hispanic schools, families, and communities. Furthermore, in low SES communities, as is the case with the school in the present study, the school is often the only means of PA (e.g., physical education, recess). The school in low SES communities becomes essential in promoting PA habits, especially among Hispanic children (The California Endowment, 2007). However, PA opportunities at school may decrease because of an increased pressure on school administrators to improve standardized test scores. Educators suggest the erosion of physical education has been a major contributor to the increased obesity rates, and NCLB is frequently cited as one of the chief causes for the current strains on physical education. The findings from this study support the notion that better AC may result in improved math performance in Hispanic girls.

The present study has several limitations. The participants were obtained using a non-random sample taken from one large urban elementary school. As such, caution should be taken in generalizing the results of this study. However, the sample used for the present study possessed characteristics similar to those of the population being studied. Although the PACER test is widely used (Morrow, Martin, & Jackson, 2010) and many consider it a reliable and valid method to assess aerobic capacity in children (The Cooper Institute,

2007), it is a one-time event, and therefore, due to various factors (e.g., illness, fatigue), results may not accurately represent students' physical abilities.

In conclusion, the results of this study may have implications for physical educators, school administrators, and policy makers. Whereas the relationship between health-related fitness measures and academic achievement for the entire group was not significant, the positive association between aerobic capacity and math performance in elementary Hispanic girls is noteworthy. Schools may play a critical role in promoting physically active lifestyles and, more important, they may be the only place of structured and unstructured PA for low SES Hispanic children. School administrators and policy makers must make time for PA during the school day by providing quality physical education, recess, classroom PA breaks, as well as before and after school PA programs. In addition, school personnel must view PA as complementary to cognitive development and achievement rather than as an impediment to instruction time and academic performance. The responsibility of the school is to educate the whole child, and the existing research suggests that PA is not a barrier to academic achievement, but rather may enhance it, particularly for school-aged children.

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