THE RELATIONSHIP BETWEEN FITNESS AND ACADEMIC ACHIEVEMENT IN AN URBAN SCHOOL SETTING

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Abstract
The purpose of this study was to examine the relationship between physical fitness (PF) and academic achievement (AA) in an urban setting. Participants (N = 172) consisted of elementary students (M_{age}=7.62, SD=.96) enrolled in physical education (PE) class. The investigators administered the FITNESSGRAM fitness test to all participants. Fitness data were compared to student achievement in language arts, reading, and mathematics as measured by criterion referenced, standardized tests. Students not receiving free or reduced lunch had significantly higher performance levels on CRCT language arts and mathematics than those receiving free lunch. Additionally, students not receiving free or reduced lunch had significantly higher performance levels on CRCT language arts than those receiving reduced lunch. Multinomial logistic regression analysis revealed that for language arts, back-saver sit-and-reach and socioeconomic status (SES) were significant predictors of meeting and exceeding expectations (back-saver sit-and-reach OR = 1.74, 95% CI = 1.06 – 2.88, Wald χ= 4.71). For every 1% increase in the back-saver sit-and-reach, students were 17% more likely to meet expectations or exceed expectations on the language arts test. For mathematics, back-saver sit-and-reach was a predictor in terms of exceeding the standards only (back-saver sit-and-reach OR = 1.34, 95% CI = .97 – 1.87, Wald χ= 3.08).

Keywords*: student learning, student performance, physical activity, physical education*

INTRODUCTION

Childhood obesity and its growing implications are now clear, as nearly one-third of the children in the United States are obese or overweight (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). From 1980 until 2006, obesity rates have increased from 6.5% to 17.0% between the ages of 6 and 11, and from 5% to 17.6% between the ages of 6 and 11 (Ogden, Carroll, & Flegal, 2008). To physical education (PE) professionals, public schools are the desired context to implement an intervention for the obesity epidemic, as it is an efficient means of providing opportunities for physical activity (PA) and PE, because they reach most adolescents and children (DeGraw, Kanner, & McGinnis, 1991; Kolbe, 1993; Collins et al., , 1995). Rather than increasing opportunities for PE in the public school system to combat the obesity epidemic, time spent in PE has decreased. Few schools provide PE for students on a daily basis for the length of the school year (Lee, Burgeson, Fulton, & Spain, 2007). Although the Centers for Disease Control (CDC) recommends 60 minutes or more of PA per day, only 18.4% of public school students reach this goal (CDC, 2010b).

The decreased emphasis on PE in the public schools is in part due to the exclusion of health and PE as one of high-stakes testing categories which serve as the basis for evaluating schools in the No Child Left Behind Act of (NCLB) 2001. The law places added pressure on schools by requiring that, by 2014, all students- regardless of race, ethnicity, socioeconomic status (SES), language or disability- meet state-determined proficiency standards in reading and mathematics or be subject to significant penalties (U.S. Department of Education, Office of Elementary and Secondary Education, 2002). The law is in many ways linked to the goals of Healthy People 2020 (U.S. Department of Health and Human Services, 2010). No Child Left Behind is the first piece of federal legislation that requires states to assess academic achievement (AA) by racial and ethnic subgroups (Fiscella & Kitzman, 2009). One of the four overarching goals of Healthy People 2020 is to eliminate health disparities and promote health equity among these same subgroups. The impetus of NCLB and many federal health recommendations present an example of conflicting federal policies (Fiscella & Kitzman, 2009). A purpose of NCLB was to eliminate achievement gaps among minorities and socioeconomic subgroups. However, it has been suggested that achievement gaps will remain until public schools address key health disparities among American school-children (Basch, 2010).

In addition to being linked in similar pieces of federal policy, student health and academic achievement have also been linked in the literature. Within the current body of research, associations among personal fitness (PF), PA, and AA have been found (CDC, 2010a). Like AA, PA needs to be viewed in the broader theoretical perspectives of social cognitive theory and ecological framework (Bandura, 1997; Bronfrenbrenner, 1979). It is important that physical educators are aware of the multiple factors which may influence PA behavior such as environment, family, community, and neighborhood (Baker, Brennan, Brownson, & Houseman, 2000; Diez-Roux, et al. 1997; Sallis & Owen, 1999). Welk (1999) presented the

Youth Physical Activity Promotion Model, a conceptual model that adopts a socio-ecological framework by drawing attention to the personal, social, and environmental influences on the PA behaviors of young people. The model takes into account how the personal demographics of age, gender, and ethnicity directly affect enabling and reinforcing factors and indirectly affect predisposing factors such as self-efficacy and attitudes. Similar models have been presented and implemented. The AS! BC model was formed by using researched based strategies on dissemination of innovations and health promotion to create a flexible model that promotes PA in schools (Naylor, Macdonald, Reed, & McKay, 2006). Because gender, race, and SES affect engagement in exercise and sport participation, culture plays a key role in promoting greater levels of interest, cognitive involvement, and motivation (Tomporowski, Davis, Miller, & Naglieri, 2008). To achieve the desired outcome of improving PF, any PA intervention must take into account the individual, culture, and context.

Some evidence suggests that including these interventions in schools will not hinder student learning. Research on human learning suggests that decreasing time spent in PE is counterproductive, as physical activity and exercise may lead to improved cognitive performance in young people. Sibley and Etnier (2003) conducted a meta-analytic review of 44 studies on the effect of PA on cognitive functioning. The authors concluded that regardless of the mode (i.e. PE, anaerobic training, aerobic training, or motor skill training), exercise and PA had a positive effect on cognition. When the outcome variable changes from cognition to AA, the research is less clear. Taras (2005) reviewed 14 studies on the effects of PA and AA and concluded that more investigation was needed before drawing conclusions on the relationship. Cross-sectional studies in a review by Truedeau and Shephard (2008) revealed a positive relationship between AA and PA, but found no association between physical fitness (PF) and AA. However, the effects of PA on academic performance may be influenced by the research design. Action Schools! BC (AS! BC) was a school-based PA intervention implemented in a multiracial group of elementary children (Ahamed et al., 2007). The AS! BC program provided students with an additional 47 minutes of PA per week, but had no effect on AA. It is important to note that providing students with additional PA via school-based interventions has been shown to improve cardiovascular (CV) fitness and decrease percent body fat (Kriemler et al., 2010). This includes a new type of PA intervention which focuses on classroom-based PA programs. Mahar et al. (2006) found that "Energizers," a classroom-based PA program, increased students' PA and on-task behavior in the classroom.

In addition to physical activity, time spent in PE is another dependent variable examined in relation to AA. Ericsson (2008) examined the effects of providing an additional three PE lessons per week on students in Sweden. The content of the intervention lessons focused on motor skill development over a 3-year period. Ericsson (2008) concluded that improvements in Swedish and mathematics coincided with an increased time spent in PE in school and that motor skill proficiency was a predictor of AA. Trudeau and Shephard (2008) also concluded that additional time in spent in PE may result in academic improvements because they are likely to increase broader affective outcomes such as school attachment and self-esteem. Examining time spent in PE at the school level has yielded similar results. Tremarche, Robinson, and Graham (2007) compared two elementary schools in Massachusetts. The school which provided more quality PE to its students scored significantly higher on the English and Language Arts (ELA) portion of the Massachusetts Comprehensive Assessment System (MCAS).

Research by health and PE professionals into the relationship between the various types of PA (e.g. physical education, classroom-based physical activity, and intramurals) is based on the notion that if students participate in more moderate-to-vigorous PA their PF levels will improve. Increased school-based PA is important considering students now spend a large portion of their time outside of school engaged in electronic media. In 2009, 32.8% of young people spend at least 3 or more hours watching television during the average school day (CDC, 2010b). Despite the potential benefits of PA on student learning, the relationship between PF and AA is less clear. What is also unclear is the relationship between PF and AA among primary grades, as many studies do not include younger ages. Previous research into the relationship between PF and AA have focused on students above the age of 10 (Hillman, Erickson, & Kramer, 2008; Hillman et al., 2009), due to reliability concerns with CV fitness tests (Meredith & Welk, 2010). Martin and Chalmers (2007) stated that while previous investigations into the relationship between PF and AA have produced statistically significant findings, the strength of the relationship has been low and of little practical significance. In their own investigation of 5,847 students in the state of Washington, PF accounted for on 3.6% of the variance in AA. The authors concluded that PE

should not be advocated as a means to improve AA.

Despite the large number of participants in Martin and Chalmer's (2007) investigation, the authors failed to take into account the role of contextual characteristics in their recommendations as they examined a single school district. In any investigation into the relationship between AA and PF, sociocultural variables need to be included in the analysis as health behaviors and AA can be affected by race/ethnicity (Duncan, Duncan, Strycker, & Chaumeton, 2002; Mezzacappa, 2004). Castelli, Hillman, Buck, and Erwin (2007) included the variable of SES in an examination of the relationship between PF and AA in elementary students. The participants came from four schools which were placed in two categories: high performing/low poverty and low performing/high poverty. In the analysis, SES status was found to be a significant predictor of AA and was therefore controlled for in the hierarchical regression analysis. The findings of Chomitz et al. (2009) concurred with those of Castelli et al. (2007) in an investigation of elementary students in Massachusetts. The authors used a logistic regression analyses and found that the likelihood of a student receiving a score defined as "passing" on MCAS testing increased as the number of PF tests passed increased. Welk et al. (2010) used a similar methodology in an examination of students in the Texas Youth Fitness Study. Welk et al. (2010) examined the phenomena at the school level. In the state of Texas, higher PF rates increased the schools' odds of achieving exemplary or recognized school status (Martin & Morrow, 2010). Welk et al. (2010) also employed a mixed-model analyses which revealed modest relationships between PF and AA.

To date, the literature has failed to reach a consensus on the relationship between PF and AA. Castelli et al. (2007) used a hierarchical regression in order to control for age, gender, and school status. Welk et al. (2010) used a logistic regression to examine the effects of student PF on the school. In a recent review of 50 studies, the CDC (2010a) cited that previous investigations of the relationship between PF and AA failed to conduct subgroup analyses beyond gender comparisons (i.e., race). The purpose of the current study was to provide a contribution to the relationship between student PF and AA by employing a combination of the statistical analyses of Castelli et al. (2007) and Welk et al. (2010) while including the sociocultural variables of race and SES.

METHODS

Participants and Setting

After securing approval from the Institutional Review Board, 172 elementary students between the ages of 4 and 9 (M_{age}=7.62, SD=.96) and enrolled in compulsory co-educational PE classes at a single, urban school participated in the study. Students were 85 males, 87 females; 55.8% Hispanic, 21.5% African American, 11% Asian, 8.7% Caucasian, 1.7% Other, and 1.2% of mixed backgrounds. Within this sample, 82% of students were receiving free or reduced lunch.

The school district requires that the PE teachers annually assess student PF levels. Each year, PE teachers receive professional development training in the selection and administration of PF tests. Student PF scores were collected by the regular PE teacher, with the assistance of other teachers at the school. The PE teacher conducted training sessions to ensure that all teachers collecting data were trained in testing protocols. The teacher held a bachelors degree in health and PE and a teacher certification (K-12) in health and physical education.

Instrumentation

Academic Achievement. Academic Achievement was measured using the Georgia Criterion Referenced Competency Test (CRCT). The CRCT was a criterion-referenced test that measured AA over the course of one school year in each academic subject area according to the Georgia Performance Standards (Georgia Department of Education, 2008). The CRCT was given to first through fifth grade students. This test was also administered to students with disabilities and limited English proficiency. Students were tested in April. The CRCT provides results to schools, parents, and teachers according to AA levels (e.g. Does Not Meet, Meets, and Exceeds). The raw CRCT scores and the dichotomous scores of the reading, language arts, and mathematics sections of the test were used in this study.

FITNESSGRAM. Muscular strength/endurance, flexibility, and body composition were measured via the FITNESSGRAM. The components included the curl-up test, flexed arm hang, and back-saver sit and reach test. The FITNESSGRAM includes a test of aerobic capacity, the Progressive Aerobic Cardiovascular Endurance Run (PACER) test. However, the PACER test has not been validated for children less than 10 years of age. While participants participated in the PACER, these data were not compared to AA. Body composition was measured using

height and weight scores which were obtained to calculate the BMI for each student. Height was measured to the nearest inch using a stadiometer. Weight was measured by using a digital scale to the nearest pound. Students wore light clothing and no shoes. Body mass index was calculated using CDC's "Children's BMI Tool for Schools" (CDC, 2011) which converts BMI scores to percentiles to account for the growth curve association with children. Students are categorized by percentile as underweight (below 5th percentile), healthy weight (5th-85th percentile), overweight (85th-95th percentile), and obese (above 95th percentile).

Procedures for Data Collection

A PF test was conducted using the FITNESSGRAM. Tests were explained to participants before data collection began. Participants were placed in small groups and went to four different stations to measure height, weight, flexed-arm hang, and back-saver sit and reach. Once participants completed the four stations, the researchers conducted the curl-up test as an entire class. The curl-up test and was conducted using the cadence for each test within the FITNESSGRAM testing manual (Meredith & Welk, 2010). Data collectors monitored participants for correct form and to ensure that students were keeping up with the cadence for the curl-up test . Data collectors had previous experience with the FITNESSGRAM in prior test administration. To ensure implementation of the FITNESSGRAM was accurate, data collectors were informed and trained in the necessary protocol of the different components by the primary researcher. For testing protocol, see FITNESSGRAM testing manual (Meredith & Welk, 2010).

Data Analysis

CRCT scores were converted into three performance levels (below, meets, or exceeds expectations) based on criteria disseminated from the state department of education. In this way, scores below 800 represented below expectations, those between 800 and 850 represented meets expectations, and scores at or above 850 representing exceeding expectations (Georgia Department of Education, 2010). Variation in FITNESSGRAM and CRCT scores across gender, race/ethnicity, and free/reduced lunch status were examined by separate Multivariate Analyses of Variance (MANOVAs). Correlation analyses were conducted to examine relationships between components of the FITNESSGRAM test and performance levels of CRCT scores, which were used to determine possible predictors of AA. Multinomial logistic regression analysis was conducted to determine the influence of PF on AA, utilizing separate regressions for each of the CRCT subjects.

RESULTS

Descriptives

Descriptive statistics for all variables can be found in Table 1. All data was found to adhere to normality assumptions. No differences were found with regards to gender. A more stringent alpha of .01 was adopted for interpretation of free/reduced lunch status and race/ethnicity, as Box M analysis revealed unequal group sizes. Additionally, Bonferroni adjustments were also made. In terms of free/reduced lunch status, only performance levels on the CRCT language arts and mathematics were significant. Students not receiving free or reduced lunch had significantly higher performance levels on CRCT language arts and mathematics than those receiving free lunch. Additionally, students not receiving free or reduced lunch had significantly higher performance levels on CRCT language arts than those receiving reduced lunch. No significant differences were found between students receiving free lunch or reduced lunch, Wilk's $\lambda = .83$, $F(14, 326) = 2.27$, $p = .006$, $\eta = .09$ (Table 1). In terms of race/ethnicity, Hispanic students' performance in the flexed arm hang tests was significantly lower than African Americans. Similarly, Hispanic and African American students had significantly higher BMI than Asian students, Wilk's $\lambda = .61$, $F(35, 675.49) = 2.44$, $p < .001$, $\eta = .10$) (Table 2).

Correlations

Correlation analysis revealed positive and significant relationships between CRCT language arts and mathematics subjects and free-reduced lunch status. Flexed-arm hang was positively yet weakly related to CRCT reading, language arts and mathematics. Components of FITNESSGRAM were highly correlated with each other, as were CRCT subject tests. BMI was negatively and moderately correlated with the flexed arm hang and CRCT reading scores. Back-saver sit-and-reach had a positive but weak correlation with the CRCT language arts subject test (Table 3).

Logistic Regression

Separate multinomial logistic regressions were carried out to determine FITNESSGRAM components' contribution to AA in reading, language arts and mathematics. Given the relationships found in the correlation analysis, flexed arm hang, BMI, back-saver sit-and-reach and free/reduced lunch status were included in

the logistic regressions. Curlups were not included.

For the CRCT reading test, FITNESSGRAM indicators did not predict achievement in terms of meeting or exceeding expectations (Table 4). For the CRCT language arts, back-saver sit-and-reach and SES were significant predictors of meeting and exceeding expectations (back-saver sit-and-reach OR = 1.74, 95% CI = 1.06 – 2.88, Wald χ^2 = 4.71). For every 1% increase in the back-saver sit-and-reach, students were 17% more likely to meet expectations or exceed expectations on the CRCT language arts subject test (Table 5). For mathematics, back-saver sit-and-reach was a predictor in terms of exceeding the standards only (back-saver sit-and-reach OR = 1.34, 95% CI = .97 – 1.87, Wald χ^2 = 3.08). FITNESSGRAM indicators were not predictors of meeting the standards on the CRCT mathematics test. Within all regressions, SES was a significant predictor of achievement, but odds ratios were minimal.

DISCUSSION

The purpose of this investigation was to examine the relationship between PF and AA in elementary school aged students. Previous research into the relationship between PF and AA has highlighted the statistically significant relationship between CV fitness and AA (Castelli et al, 2007; Martin & Chalmers, 2007; Wittberg, Northrup, & Cottrel, 2009). These findings are consistent with previous research on the relationship between CV fitness and neurocognitive function (Hillman et al., 2005), the effects of PA on on-task behavior (Mahar et al., 2006), the relationship between PA and AA (Trudeau & Shephard, 2008), the effects of exercise on cognition and AA (Hillman et al., 2008; Hillman et al., 2009). The results of this study indicate that other indicators of PF may predict AA in students less than 10 years of age, as flexibility was a significant predictor of both language arts and mathematics achievement. This is consistent with previous research which used logistic regression to find that an increase in number of healthy fitness zones (HFZ) achieved on the FITNESSGRAM corresponded with increases in AA at the student (Chomitz et al, 2009) and school level (Welk et al., 2010). The findings suggest that further research continue to investigate the nature of the relationships among PF indicators and AA in students younger than 10 years of age.

The evidence of a relationship between flexibility and AA in the results also provides support for the role of quality PE in schools. The National Association for Sport and Physical Education ([NASPE] (2004) stated that "quality" PE programs provide students with opportunity to learn, meaningful content, and appropriate instruction. A program with these components is able to promote positive student outcomes. "It is the unique role of quality PE programs to help all students develop health-related fitness, physical competence, cognitive understanding, and positive attitudes about PA so that they can adopt health and physically active lifestyles," (NASPE, 2004, p. 4-5). Sallis, McKenzie, and Alcaraz (1993) found that PA was positively correlated to all components of PF. As children grow and develop, basic movement patterns evolve into coordinated patterns of movement, resulting in the acquisition of specialized skills that are incorporated into play, games, and sport (Strong et al., 2005). In order to promote activity among young people the CDC (1997) recommends that PE programs meet the following guidelines: a) provide planned sequential PE that promotes lifelong activity, b) develop students' knowledge and positive attitudes toward physical activity, and c) develop a mastery of skills and confidence in PA among students. Skill proficiency during adolescence and sport participation in preadolescence are predictors of future, adult activity levels (Taylor, Blair, Cummings, Wun, & Malina, 1999). The findings of the current study, as well as others mentioned previously, which have found positive relationships between PA/PF and AA, suggest the need for daily, quality PE.

The analysis also included the sociocultural variables of race and SES. Variances among student PF levels in different contexts are often influenced by cultural and societal factors, but few studies have taken them into account (Zhu, Boiarskaia, Welk, & Meredith, 2010). While previous research has focused on the relationship between the variables of PF and AA, few studies have expounded upon the significance of the findings for a particular context. There were significant differences in AA and PF between students receiving free and reduced lunch and students receiving no assistance. Significant differences among Asian and Black/Hispanic students and among Caucasian and Black/Hispanics students suggest the presence of a phenomenon identified in American public schools known as the *achievement gap* (Jencks & Phillips, 1998) or differences in AA between minority and socioeconomically disadvantaged students and their more advantaged peers. These gaps were also present in this study, as students not receiving free or reduced lunch scores significantly higher in language arts. Many traditional strategies such as additional tutoring fail to address the notion that these

achievement gaps may persist due to psychological or sociocultural factors. Previous research has shown that such factors can play a key role in intellectual achievement (Bandura, 1986; Dweck, Chiu, & Hong, 1995; Zigler & Butterfield, 1968).

The findings of this study add to the growing body of research on the relationship between PF and AA. Future research should focus on interventions which provide additional PA and/or PE within the school setting. School-based PA interventions can improve PF without hindering academic achievement and can also improve student on task behavior (Ahamed et al., 2007; Kriemler et al., 2010; Mahar et al., 2006). Previous research has also highlighted the need to include sociocultural variables in any analysis of health behaviors or academic achievement (Duncan, et al., 2002; Mezzacappa, 2004). These variables need to be addressed in school-based physical activity intervention, as culture can also affect student responsiveness to such interventions (Tomporowski et al., 2008). Spector (1996) defined culture as "the sum of beliefs, practices, habits, likes, dislikes, norms, customs, rituals, and so forth that we learn from our families during the years of socialization," (p. 68). The role of culture and the need for a focus on the implementation of school-based interventions indicates the need for culturally responsive, school- and community-based interventions to promote PA and PF and the need for physical educators to examine cultural factors and their potential influence on student learning.

CONCLUSION

Research showing a relationship between PF and AA is beneficial for the field of kinesiology and sport, as it provides practitioners with data to advocate for their profession. The findings of the current study point to the need for a holistic approach to promote PF in PE settings, as factors other than CV fitness were found to predict AA. In addition, since PF is regarded as a proxy for PA, its various components must be continuously evaluated within this population. Only trained practitioners can evaluate, plan and implement appropriate instruction that will promote improvement in all areas of PF and student learning to foster lifetime physical activity.

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POVEZANOST IZMEĐU FITNESSA I ŠKOLSKOG USPJEHA U GRADSKIM SREDINAMA

Originalni naučni rad

Sažetak

Svrha ove studije je istražiti vezu između fizičke spreme i akademskih dostignuća (AA) u gradskim sredinama. Učesnici (N=172) su bili učenici osnovne škole koji su pohađali fizičko vaspitanje (PE). Istraživači su primjenili FITNESSGRAM test nad svim ispitanicima. Podaci o fizičkoj spremi su upoređivani sa znanjem jezika, čitanja i matematike, mjereno standardnim testovima. Učenici koji nisu primali besplatni ili smanjeni ručak su imali značajno bolje rezultate na CRCT iz jezika i matematike, nego oni koji su primali besplatni ručak. Multinominalna logistička regresiona analiza otkriva da su za jezičke sposobnosti, test fleksibilnosti (sit-and-reach) i drustveno-ekonomski status (SES) značajni prediktori očekivanih i premašenih očekivanja (sit and reach OR=1.74, 95% CI=1.06- 2.88 Wald χ=4.71). Za svakih 1% povećana na testu sit-and-reach, učenici su imali za 17% veće šanse da dostignu ili premaše rezultate iz jezičkih sposobnosti. Što se tiče matematike, test sit-and-reach je bio prediktor samo u smislu premašivanja standarda (test sit-and-reach OR=1.34, 95% CI = .97 – 1.87, Wald χ= 3.08).

Ključne riječi: *učenje, učenička izvedba, fizička aktivnost, fizičko vaspitanje.*

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