

FITNESS

Associations of Physical Fitness and Academic Achievement Among Illinois High School Students

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Abstract

The health benefits of physical activity are empirically supported and well accepted. However, the relationship between physical activity, physical fitness, and academic performance remains to be clearly established. The purpose of this study was to identify the relationship between physical fitness and academic achievement among a sample of Illinois high school students. Analyses were based on the 2016–2017 school year Archival Fitnessgram physical fitness test scores and cumulative GPAs of ninth- through twelfth-grade students (N = 371). Pearson correlation assessed the relationship between physical fitness and academic performance. Multiple linear regression predicted students' academic achievement. There was a positive association between total fitness and academic achievement, although not statistically significant, $r(369) = .002$, $p = .49$. The regression prediction model was statistically significant ($p < .001$) and accounted for approximately 25% of the variance in academic achievement ($R^2 = .256$, adjusted $R^2 = .246$). Academic achievement was predicted by total number of absences and gender, and to a lesser extent by socioeconomic status, the curl-up, and ethnicity. The findings of this study suggest a positive association between physical fitness and academic achievement. These results are potentially relevant to the development of future education policies. Thus, policy makers, school administrators, and educators must use the knowledge gained in this study, along with existing research, as

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evidence to emphasize the importance of the fitness–academic link, to further support the need for quality physical education curriculum and mandated physical fitness testing.

During the last 4 decades, the prevalence of diseases associated with childhood obesity impacting physical and emotional well-being has reached epidemic proportions, with lack of physical activity being a significant contributor (Ogden et al., 2012). Although the benefits of physical activity are well documented, the Centers for Disease Control and Prevention (CDC, 2016a) has estimated that 65% of adolescents do not get the recommended amount of physical activity each day. Furthermore, only 27.1% of high school students meet current recommendations for physical activity and only 29.8% attend physical education classes daily (CDC, 2016b; Kann et al., 2016).

Schools serve as the perfect venue to provide daily physical activity; however, physical education has been substantially reduced in schools across the United States. This reduction and elimination of physical education comes in response to both budgetary concerns and increased pressure for academic accountability (Coe et al., 2006; Trost, 2009). Many state legislators and school administrators have questioned the value of physical education and claimed that time devoted to physical education detracts from academic performance; however, research has refuted this notion (CDC, 2011).

Given the increased rates of childhood obesity and its associated health implications, coupled with the increased pressure among school administrators to improve student academic performance, a number of studies have assessed the relationship between physical activity and academic achievement. However, the relationship between standardized fitness assessments, such as the Fitnessgram, and academic achievement among high school students has received less attention (Bass et al., 2013). Of those studies, many have been inconclusive in recognizing the fitness–academic link with regard to absenteeism and sociodemographic variables that may influence the relationship (Blom et al., 2011). The purpose of this study was to quantify the cross-sectional association between academic achievement (GPA) and measures of physical fitness (Fitnessgram), including the potential for confounding variables such as gender,

ethnicity, and socioeconomic status among a sample of Illinois high school students.

Method

Participants

Participants for the study included ninth- through twelfth-grade students ($N = 371$) from a rural Illinois high school who were enrolled in physical education class and completed the Fitnessgram physical fitness test during the 2016–2017 school year. Archival Fitnessgram physical fitness test scores, cumulative GPAs, and additional socio-demographic data (including age, grade level, gender, ethnicity, socioeconomic status, and absenteeism records) were utilized in the assessment of student fitness and academic performance.

Measuring Instruments

Physical fitness was measured with four independent fitness tests from the Fitnessgram developed by the Cooper Institute. The Fitnessgram includes a battery of fitness tests that measure the various components of physical fitness necessary for good health, including aerobic capacity, body composition, muscular strength, endurance, and flexibility (Plowman et al., 2013). The Fitnessgram uses criterion-referenced standards to measure the fitness level of students and is intended to be administered during school-based physical education programs (Meredith & Welk, 2010; Plowman et al., 2013). Criterion-referenced standards are used as opposed to percentile norms because they are based on individual levels of good health specific to gender and age (Plowman et al., 2013). The use of health-related criteria emphasizes personal fitness for health rather than setting goals based on performance (Meredith & Welk, 2010). The Fitnessgram classifies fitness levels using two primary zones called the Healthy Fitness Zone (HFZ) and the Needs Improvement Zone (NIZ). The HFZ determines the level of fitness required for a low risk of future health problems, and students scoring in the NIZ are potentially at risk for future health problems (Plowman et al., 2013). A participant's score on each fitness test determines if the participant is in the HFZ or NIZ based on their gender and age. The goal of the Fitnessgram is for students to achieve the HFZ in

as many assessment areas as possible. For the purpose of this study, participants were categorized as HFZ or NIZ for each fitness test and for the combination of three of the fitness tests (PACER, 90-degree push-up, and curl-up). The Back Saver Sit and Reach was not included in the total fitness score because only sophomores completed the assessment. In addition, data on body composition were not collected at the selected school and were, therefore, not available for this study. The Illinois State Board of Education mandates that all fitness tests be conducted all 4 years of high school, with the exception of the Back Saver Sit and Reach (Illinois State Board of Education, 2017a). The Fitnessgram has been established as both valid and reliable and is commonly used throughout the United States as part of physical education curriculums (Plowman et al., 2013).

Academic achievement was measured through student cumulative GPAs. GPAs were calculated by teachers in the selected school and were determined from students' cumulative scores from the final quarter of the 2016–2017 school year. Numerical values were assigned to letter grades such as 4 (A), 3 (B), 2 (C), 1 (D), 0 (F) and the total number of points were added and divided by the number of classes for the GPA. GPAs were matched with the students' Fitnessgram scores and information was then de-identified. We acknowledge the lack of reliability and validity of using GPA as a measure of academic achievement. Although use of standardized test scores may be a more likely choice for measuring academic achievement, GPA data are readily available for all students. Furthermore, the use of high school GPA has proven to be more predictive of students' success in English and Math college courses, as opposed to the use of their scores on standardized tests (Hodara & Cox, 2016).

Additional archival sociodemographic data including age, grade level, gender, ethnicity, socioeconomic status, and absenteeism records were retrieved by the selected school's principal. These data were then matched with respective students' Fitnessgram scores and GPAs and then de-identified before being reported.

Data Analysis

Data were analyzed with SPSS 22. We categorized and coded the participants as fit or not fit based on their achievement of the HFZ for individual fitness tests and total fitness. Pearson's product-moment correlation determined the relationship between physical fitness and academic achievement. Multiple linear regression analysis predicted GPA based on the combined effects of all independent variables.

Results

Characteristics of the Study Population

The population at the selected high school consisted of 1,051 students ($n_{9\text{th}} = 304$, $n_{10\text{th}} = 261$, $n_{11\text{th}} = 214$, and $n_{12\text{th}} = 272$), with males representing 52% of the population. Caucasian students represented 57% of the population; Hispanic, 34%; African American, 4%; multiracial, 3%; American Indian, 0.4%; and Asian, 0.4%. Average daily attendance rate was 91% (Illinois State Board of Education, 2017b) and approximately 47% of the population received free or reduced lunch (Illinois State Board of Education, 2017b).

Characteristics of the Sample Pool

The sample pool consisted of all ninth- through twelfth-grade students who participated in the battery of Fitnessgram physical fitness tests during their physical education class in Spring 2017 and also had an up-to-date cumulative GPA. The sample is believed to be representative of the ninth- through twelfth-grade student population at the selected school based on comparable percentages of their demographic information, including gender, ethnicity, and socioeconomic status.

Table 1 shows the descriptive statistics for the categorical demographic variables used in this study. Table 2 reports the descriptive statistics for the continuous demographic variables used in this study, along with GPA and the mean and standard deviations for each individual fitness test. Table 3 reports the number of students who reached the HFZ for each individual fitness test.

Table 1
Summary of Categorical Demographic Information

Variable	Frequency	%
Sex		
Male	220	59.3
Female	151	40.7
Year in school		
9	114	31.0
10	130	35.0
11	81	21.8
12	46	12.4
Race/ethnicity		
Caucasian	205	55.3
Hispanic	136	36.7
Black	10	2.7
Multiracial	12	3.2
Asian	4	1.1
American Indian	2	0.5
Socioeconomic status		
Free/reduced lunch	207	55.8
Paid lunch	164	44.2

Table 2
Summary of Continuous Demographic Information

Variable	Range	<i>M</i>	<i>SD</i>	Skewness	Kurtosis
Age	14–19	16.05	1.16	-.232	-.478
Absences	0–60.5	10.18	9.72	1.898	4.742
Total fitness	3–6	4.90	0.82	-.349	-.440
PACER	0–63	33.45	13.61	-.064	-1.174
Push-up	0–40	16.22	8.62	.404	.096
Curl-up	6–80	54.90	24.67	-.099	-.591
Sit & reach	4.25–12.0	10.28	1.94	-1.201	.954
GPA	0.56–4.0	2.46	0.76	-.099	-.591

Table 3
Summary of Fitnessgram Data

Test	No. completed	No. reached HFZ	No. reached HFZ
PACER	371	118	32
Push-up	371	247	67
Curl-up	371	337	91
Sit & reach	101	71	70

The prediction model for GPA based on the combined effects of all independent variables (total fitness, individual components of fitness, gender, ethnicity, grade level, socioeconomic status, and number of absences) was statistically significant ($p < .001$) and accounted for approximately 25% of the variance of GPA ($R^2 = .256$, adjusted $R^2 = .246$). GPA was partially predicted by total number of absences and gender (females reporting higher GPA), and to a lesser extent by socioeconomic status, the curl-up, and ethnicity (Caucasians and Asians reporting higher GPA). Table 4 shows the raw and standardized regression coefficients of the predictors together with their correlations with GPA, along with their squared semipartial correlations.

Table 4
Stepwise Regression Analysis Predicting GPA

Model	B	SE B	B	<i>r</i>	<i>Sr</i> ²
Constant	2.486	.109			
Absences	-.027	.004	-.342	-.373	
Gender	.429	.072	.278	.235	.062
Socioeconomic status	-.267	.070	-.175	-.220	.028
Curl-up	.004	.001	.139	.099	.019
Ethnicity	.662	.333	.091	.119	.008

Note. The dependent variable is GPA. $R^2 = .256$, adjusted $R^2 = .246$. Sr^2 is the squared semipartial correlation.

Discussion

A number of studies have provided evidence that physical fitness is positively associated with academic achievement (Blom et al., 2011; Castelli et al., 2007; Chomitz et al., 2009; Fedewa & Ahn, 2011; Hillman et al., 2009; Van Dusen et al., 2011). Results from this study are consistent with these findings, although no statistically significant relationship was found in this study. One plausible explanation for this is that athletes at the selected school are allowed to waive out of physical education courses during their junior and senior years. Research indicates that athletes typically have a higher GPA than nonathletes, are more physically fit, and have less total school absences (Lumpkin & Favor, 2012). Hence, theoretically, the students who would achieve the highest level of fitness and academic achievement may have been left out of the study, contributing to the nonsignificance of the relationship.

Within the few studies that have been conducted regarding associations between muscular strength, endurance, and academic achievement, positive associations were found between abdominal strength (utilizing the curl-up test) and academics. However, associations were weakened after controlling for potential covariates, such as age and socioeconomic status (Chu et al., 2016). The results of this study confirm findings from previous studies, as a positive association was found between the curl-up and GPA, after controlling for confounding variables.

When determining if the aforementioned sociocultural variables, along with total physical fitness scores, were significant predictors of GPA, this study found that the combination of these variables accounted for 24% of the variance in GPA. Although a definitive explanation for the variance in GPA cannot be provided, it is well documented that both lower socioeconomic levels and higher total absences are independently associated with lower academic achievement, thus providing a plausible explanation as to why these variables significantly contributed to the model (Castelli et al., 2007). These results further justify the need for investigation of all factors that influence academic achievement, including physical fitness.

Limitations

The main limitation of this study is that it was undertaken with a convenience sample and this may limit its generalizability across the population. Furthermore, although the physical education teachers at the selected school were certified and trained to conduct and collect data for the Fitnessgram physical fitness tests, the reliability of the data collection was unknown. Consequently, systematic bias may be compromised because of inconsistent data quality. The final limitation is that, as previously noted, junior and senior athletes at the selected school were allowed to waive out of physical education courses. Athletes typically have a higher GPA than nonathletes, are more physically fit, and have less total school absences (Lumpkin & Favor, 2012); therefore, the students who would achieve the highest level of fitness and academic achievement may have been left out of the study.

Implications for School Health and Physical Education

The results of this work carry implications for research, policy, and health and physical educators. For researchers, further examination longitudinally into the relationship between physical fitness and academic achievement for grades K–12 is recommended. In addition, the influence of confounding variables such as gender, ethnicity, socioeconomic status, and absenteeism rates needs to be further explored because the literature surrounding this is limited and contradicting. For health and physical education policy makers, advocating for common physical education guidelines and policies across all states is necessary. This includes the development and implementation of nationwide physical fitness testing procedures and guidelines for fitness testing and reporting requirements for individual, as opposed to aggregate, level data so that students' health and academics can be monitored longitudinally. For health and physical educators, the potential impact of physical fitness on academic performance should be considered when developing curriculum and allocating funds from legislation, such as the Every Student Succeeds Act, to hire additional certified physical education teachers, build necessary and appropriate physical education facilities, purchase physical education equipment, and properly schedule physical education classes. Physical education requirements are strongest for

elementary students; however, the association of fitness with academic achievement among high school students was identified in this paper. Given these findings, significant efforts should be made toward the sustainment of an effective physical education curriculum during high school.

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