

# Effect of Physical Education and Activity Levels on Academic Achievement in Children

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## ABSTRACT

COE, D. P., J. M. PIVARNIK, C. J. WOMACK, M. J. REEVES, and R. M. MALINA. Effect of Physical Education and Activity Levels on Academic Achievement in Children. *Med. Sci. Sports Exerc.*, Vol. 38, No. 8, pp. 1515–1519, 2006. **Purpose:** This study was conducted to determine the effect of physical education class enrollment and physical activity on academic achievement in middle school children. **Methods:** Participants were 214 sixth-grade students randomly assigned to physical education during either first or second semesters. Moderate and vigorous physical activity (MVPA) (number of 30-min time blocks) outside of school was assessed using the 3-d physical activity recall (3DPAR). The 3DPAR time blocks were converted to ordinal data with scores of 1 (no activity), 2 (some activity), or 3 (activity meeting Healthy People 2010 guidelines). Academic achievement was assessed using grades from four core academic classes and standardized test scores (Terra Nova percentiles). **Results:** Grades were similar regardless of whether students were enrolled in physical education during first or second semesters. Physical education classes averaged only 19 min of MVPA. Students who either performed some or met Healthy People 2010 guidelines for vigorous activity had significantly higher grades ( $P < 0.05$ ) than students who performed no vigorous activity in both semesters. Moderate physical activity did not affect grades. Standardized test scores were not significantly related to physical education class enrollment or physical activity levels. **Conclusion:** Although academic achievement was not significantly related to physical education enrollment, higher grades were associated with vigorous physical activity, particularly activity meeting recommended Healthy People 2010 levels. **Key Words:** PEDIATRICS, EXERCISE, SCHOOL, ACADEMIC PERFORMANCE

Daily physical education class may provide the opportunity for children to meet Healthy People 2010 guidelines for physical activity (22). Many school districts, however, are reducing physical education requirements, and some are eliminating programs (19). The percentage of schools requiring physical education in each grade decreases from approximately 50% in grades 1–5, to 25% in grade 8, to only 5% in grade 12 (5). Daily participation in physical education among high school youth at the national level is 29.1%, and participation declines as students progress through grades 9 (42.1%), 10 (30.4%), 11 (20.0%), and 12 (20.1%) (4).

Physical education classes are being replaced with other classes in an effort to increase the students' academic achievement as measured by standardized tests. Despite this trend, no clear evidence indicates that academic achievement will improve if physical education classes are cut.

Numerous studies have shown positive relationships between academic achievement and both physical activity (3,8,10–12,16–18,20) and sports participation (7), whereas a few have shown no correlation (6) or an inverse relationship (21). The mechanisms by which students may improve academic achievement as a result of increased physical activity through physical education include increased arousal and reduced boredom, which may lead to increased attention span and concentration. Increased activity levels might also be related to increased self-esteem, which could be expected to improve classroom behavior as well as academic performance (16). Most previous studies are cross-sectional. Longitudinal evaluation of physical education classes, physical activity participation, and academic achievement may provide more complete information of their true relationships. This investigation was conducted to determine the effect of physical education class enrollment and overall physical activity on academic achievement in middle school children over the course of an academic year.

## METHODS

**Study participants.** Participants were 214 sixth-grade students from a single public school in western Michigan. The average income for this school district is higher when compared with the average income of the state of Michigan.

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The racial breakdown of students in the district is 62.7% white, 17.5% Hispanic, 8.6% Asian, 5.8% multiracial, 3% black, 0.2% Native American, 0.1% Pacific Islander, and 2.1% other. There were 7875 students enrolled in these schools (K–12) for the 2002–2003 academic year. Each of the 622 sixth-grade students in the school had the opportunity to be involved in the study. A packet containing the consent and assent forms was sent home with each student on the first day of school (August 2002).

In accord with school policy, all sixth-grade students were randomly assigned to one of four teams by administrators. Each team consisted of one teacher from each of the core classes (mathematics, science, English, and world studies). Each student on a given team had the same teachers for the core classes, but they were randomly assigned the order in which they had each class. There were only two physical education teachers and one teacher for each exploratory class, which is why the students were randomly assigned these classes for only one semester. Students were not permitted to switch teams or to request a team to be with friends. The assignment process was serendipitous, rather than the result of a preplanned study. For the purpose of this study, students were placed into one of two groups. One group was enrolled in physical education during the first semester (August to mid-January), and the other group was enrolled in physical education the second semester (mid-January to June). During the semester that the students did not have physical education, they were enrolled in an alternative exploratory class (i.e., arts and computer classes). All classes met every day of the week for 55 min.

The students participated in the study on a volunteer basis. All students in sixth grade received a packet containing an informational letter about the study as well as assent and consent forms on the first day of school. The students who returned the signed assent and consent forms were included in the study. The participation rate was 36.8% (229 of 622). Complete data collection was obtained on 93.4% (214 of 229) of the students who participated. Each participant was assessed three times: at the beginning (August–September), middle (January), and end (May–June) of the school year. The study was approved by the university's committee on research involving human subjects at Michigan State University. Written informed child assent and parental consent were obtained before each participant entered the study.

**Anthropometry.** Height was measured to the nearest millimeter with a field anthropometer (GPM, Martin type; Pfister Import-Export, Inc., Carlstadt, NJ) by one trained technician. Weight was measured to the nearest 0.1 kg using a calibrated digital scale (Precision Health Scale UC-300, Milpitas, CA). The body mass index (BMI;  $\text{kg}\cdot\text{m}^{-2}$ ) was then calculated.

**Physical activity recall.** Habitual physical activity was estimated using the 3-d physical activity recall (3DPAR), a variation of the previous day physical activity recall developed by Weston et al. (23). The 3DPAR asks each child about his or her previous day's activities for

three consecutive days. Specifically, the child was asked to recall on Wednesday activities that had been performed on the previous Sunday, Monday, and Tuesday. These 3 d were divided into 30-min blocks, and participants were instructed to choose a single activity code for each 30-min block. If the child performed more than one activity, the activity performed for most of that 30-min period was listed. For each 30-min block, the child also provided an intensity level for the activity performed.

MET values for each activity in the questionnaire were obtained from a previous validation study (23) and the compendium of physical activity (1,2). For analytic purposes, the number of 30-min time blocks of moderate ( $\geq 3.0$ –5.99 METs) and vigorous ( $\geq 6.0$  METs) activity was used to determine each child's level of activity outside of school. In addition to the 30-min blocks for moderate and vigorous activity, activity scores were converted to ordinal data. Scores of 1 (no activity), 2 (some activity), or 3 (activity that meets Healthy People 2010 guidelines) were given to each student, based on activity levels, for moderate and vigorous activity. This conversion was performed because youth are encouraged to meet the guidelines for physical activity set by the Healthy People 2010 program. Healthy People 2010 guidelines for moderate activity are  $30 \text{ min}\cdot\text{d}^{-1}$  for at least  $5 \text{ d}\cdot\text{wk}^{-1}$  and, for vigorous activity,  $20 \text{ min}\cdot\text{d}^{-1}$  for at least  $3 \text{ d}\cdot\text{wk}^{-1}$  (22).

**Academic achievement.** Academic achievement was based on individual grades for each student in the core classes (mathematics, science, English, and world studies) and a standardized test score. For analytic purposes, individual letter grades were converted to numeric data: A = 5, B = 4, C = 3, D = 2, F = 1. Grades for the four courses were summed over two marking periods to calculate a grade score for each semester. First-semester grades were reported in November and January, and second-semester grades were reported in April and June. Numeric grade scores could range from 8 (all Fs) to 40 (all As).

Terra Nova standardized test scores were also used as a measure of academic achievement. Terra Nova scores are derived from a national standardized test, which consists of multiple assessments of reading or language arts, mathematics, science, and social studies. The test is administered in April (second semester), and scores (percentiles) can range from 1 to 99.

**System for Observing Fitness Instruction Time (SOFIT).** The System for Observing Fitness Instruction Time (SOFIT) involves direct observation of physical education classes while recording student activity levels, curriculum context variables, and teacher behavior (9). A single observer assessed time spent in an activity as well as student and teacher behavior during a physical education class. Each physical education teacher was observed a total of four times, twice during each semester of the school year. The SOFIT data were used to provide descriptive information regarding the quantity of physical activity performed during physical education class, teacher behavior, and also the type of activity generally performed during the class. These qualitative evaluations were performed

TABLE 1. Subject age, anthropometric, and demographic data by semester physical education participation (mean  $\pm$  SD, range).

Age/Anthropometric/ Demographic Variables	Physical Education First Semester (N = 100)	Physical Education Second Semester (N = 114)
Age (yr) mean $\pm$ SD	11.5 $\pm$ 0.4	11.4 $\pm$ 0.4
Range	10.0 – 12.8	10.8 – 12.9
Height (cm) mean $\pm$ SD	147.7 $\pm$ 6.4	148.3 $\pm$ 8.0
Range	133.5 – 166.2	126.4 – 165.3
Weight (kg) mean $\pm$ SD	46.7 $\pm$ 12.3	44.2 $\pm$ 12.4
Range	28.3 – 85.6	24.9 – 95.8
Body mass index (BMI) (kg·m <sup>-2</sup> ) mean $\pm$ SD	21.3 $\pm$ 4.9	20.0 $\pm$ 4.1*
Range	13.7 – 34.3	13.1 – 37.3
Sex		
Boys	51%	51%
Girls	49%	49%
Race		
White	68%	68%
Hispanic	14%	10%
Black	3%	4%
Asian	3%	6%
Other†	12%	12%

\* Significant difference at  $P < 0.005$  level.

†In the demographic group, "other" included Hispanic-white, black-white, Asian-white, Hispanic-black mixes, and Native-American.

subsequent to the statistical analyses to help explain major research findings.

**Statistical analyses.** Age and anthropometric and demographic characteristics were compared between the assigned semester groups (i.e., physical education first semester vs physical education second semester) using unpaired *t*-tests. Shapiro–Wilk test results showed that outcome variables (grades and Terra Nova scores) were not normally distributed. Therefore, differences in academic achievement were evaluated using Kruskal–Wallis analysis (JMP, SAS Institute Inc.). We determined whether there were differences in academic achievement as a function of semester of enrollment in physical education and level of physical activity.

## RESULTS

Age and anthropometric and demographic characteristics of the sample are shown in Table 1. The only significant difference between the groups was in BMI. Because no pretest grade data were available, only midpoint (end of first semester) and posttest (end of second semester) data for combined scores are presented in Tables 2 and 3. Academic achievement (combined scores) was not affected by the timing of physical education class enrollment (i.e., first or second semester) (Table 2). The Terra Nova standardized test scores, expressed as percentiles, were also not affected by physical education class enrollment ( $55.3 \pm 27.5$  (first semester) vs  $60.6 \pm 20.3$  (second semester)). However, students who performed vigorous physical activity at a level that met or exceeded the Healthy People 2010 guidelines

TABLE 2. Midpoint and posttest academic achievement variables by physical education semester (mean  $\pm$  SD).

Academic Achievement Variables	First Semester Combined Score	Second Semester Combined Score
First semester (N = 100)	33.4 $\pm$ 6.9	33.1 $\pm$ 7.7
Second semester (N = 114)	32.5 $\pm$ 7.5	32.2 $\pm$ 6.9

TABLE 3. Distribution of grades, moderate, and vigorous physical activity (mean  $\pm$  SD).

Physical Activity Variables	First Semester Combined Score	Second Semester Combined Score
Moderate physical activity (1 = no activity) (N = 55, first semester; N = 33, second semester)	34.3 $\pm$ 6.1	30.4 $\pm$ 7.9
Moderate physical activity (2 = some activity) (N = 47, first semester; N = 36 second semester)	33.7 $\pm$ 6.5	33.5 $\pm$ 6.8
Moderate physical activity (3 = activity meeting Healthy People 2010 guidelines) (N = 92, first semester; N = 119, second semester)	33.4 $\pm$ 7.6	33.2 $\pm$ 7.5
Vigorous physical activity (1 = No activity), (N = 145, first semester; N = 131, second semester)	32.9 $\pm$ 6.8	32.0 $\pm$ 7.5
Vigorous physical activity (2 = some activity), (N = 12, first semester; N = 11, second semester)	35.5 $\pm$ 6.9*	31.6 $\pm$ 11.3
Vigorous physical activity (3 = activity meeting Healthy People 2010 guidelines) (N = 37, first semester, N = 46, second semester)	35.9 $\pm$ 5.9*	35.1 $\pm$ 5.7†

\* Significantly different from level 1 vigorous physical activity,  $\chi^2 = 10.1$ ;  $df = 2$ ;  $P < 0.006$ .

†Significantly different from level 1 and 2 vigorous physical activity  $P < 0.05$ ,  $\chi^2 = 6.05$ ;  $df = 2$ ;  $P < 0.049$ .

achieved higher academic scores compared with the other students in both first ( $\chi^2 = 10.1$ ;  $df = 2$ ;  $P < 0.006$ ) and second ( $\chi^2 = 6.05$ ;  $df = 2$ ;  $P < 0.049$ ) semesters (Table 3). No significant differences were found in academic achievement and Terra Nova scores as a function of activity level during either semester (moderate physical activity  $56.0 \pm 25.4$  (1) vs  $56.5 \pm 24.6$  (2) vs  $57.4 \pm 25.7$  (3); vigorous physical activity  $57.0 \pm 25.5$  (1) vs  $70.8 \pm 16.3$  (2) vs  $55.5 \pm 26.1$  (3)).

## DISCUSSION

We hypothesized that students enrolled in physical education would have better academic achievement than those not enrolled in physical education because of increased levels of physical activity gained during class time. We also hypothesized that students who achieved Healthy People 2010 guidelines for physical activity would have the highest academic achievement. Physical education class enrollment status did not influence academic achievement in core classes. Using SOFIT, we determined that an average of 19 min of the 55-min class period was spent in moderate to vigorous activity. This low level of activity may not provide sufficient stimulation to influence academic achievement.

Shephard (16) has suggested that increased physical activity during the school day may induce arousal and reduce boredom, which can lead to increased attention span and concentration. Shephard also suggested that increased activity levels might be related to increased self-esteem, which would improve classroom behavior as well as performance. It is possible that a threshold level of activity may be needed to produce these potentially desirable effects. This may explain why increases in academic performance are associated with vigorous activity and not with moderate physical activity in the present investigation.

Results from the Trois Rivières study (Quebec, Canada) indicate that students who received an hour of physical education per day in addition to the standard physical education class (1 d·wk<sup>-1</sup> for 40 min) showed better academic performance compared with control subjects who only had the standard physical education class (17). The authors assessed academic achievement using average grades for French, English, mathematics, natural science, and conduct. These subjects were similar to the core classes used to assess academic achievement in the present study. The Trois Rivières findings suggest that if students in physical education receive an adequate amount of physical activity during class sessions, they may perform better academically.

Students enrolled in physical education class during the present study did not perform better academically than those who had an extra 55 min of classroom time. Decreased classroom time, however, did not translate into a lesser academic performance, either. Previous research where additional time during the school day was allocated to physical education programs showed similar results, demonstrating that decreased time spent in academic programs did not adversely affect the academic performance of the students (6,14).

Grades were also compared with out-of-school, self-reported physical activity levels. The amount of moderate physical activity performed by the students did not affect academic achievement. A significant association, however, is found between vigorous activity and academic achievement. During the first semester, when the study participants performed any amount of vigorous activity, they performed better academically compared with students who participated in no vigorous activity. In the second semester, only students who reached or exceeded Healthy People 2010 recommendations for vigorous activity performed better academically compared with students who performed only a small amount of, or no, vigorous activity (Table 3). These findings could be interpreted as showing that the vigorous activity levels may meet the threshold of physical activity intensity necessary to positively influence academic performance. It is also possible, however, that these associations represent confounding by socioeconomic status. The relationship between physical activity and academic achievement that is observed in this study may no longer be significant when controlling for socioeconomic status. Previous research has shown that socioeconomic status is related to higher levels of physical activity and more sports participation in youth (12,13). This may explain why children who participate in vigorous physical activity, such as sports, perform better in school.

In a comprehensive review, Keays and Allison (8) noted several studies demonstrating the positive effects of daily moderate to vigorous physical activity on student performance and academic achievement. Academic achievement in individual studies was defined as memory, observation, problem solving, and decision making. These measures of academic achievement differ from those in the current study. Nevertheless, the results still indicate an association between increased levels of physical activity and improved academic performance.

The only study that provides a comparable design to the present investigation is the Trois Rivières study (17). The study designs were similar, except that all students received the treatment (physical education) in the present study. Academic achievement was assessed using grades from core classes in both studies. In the Trois Rivières study, physical activity over the course of an entire day was assessed using diaries and physical activity recalls. In the present study, physical activity outside of school was assessed using a 3DPAR. Habitual physical activity outside of school was similar in the experimental and control groups in both studies (15). The results indicate that increased academic achievement in the Trois Rivières study was influenced by the increased time spent in physical education classes. Our study showed that physical activity outside of school influenced academic achievement, not physical activity performed during physical education class.

Standardized test scores were also analyzed in the present study. The Terra Nova test was administered during the second semester (April). Although the results were not statistically significant ( $P < 0.12$ ), test scores were approximately 10% higher for students who were concurrently enrolled in physical education class ( $55.3 \pm 27.5$  (physical education first semester) vs  $60.6 \pm 22.3$  (physical education second semester)).

As noted, a threshold of activity intensity may be needed to bring about changes in the child that contribute to increased academic achievement. Activity of vigorous intensity may be necessary to achieve the threshold. In the present study, many participants attained activity of vigorous intensity in sports participation. It is possible that sports participation provides an adequate intensity level to meet the threshold necessary to see desirable effects of physical activity on fitness and academic achievement. During the first semester, 48.5% of students played on sports teams, with most playing soccer and football. During the second semester, 37.5% of students played on sports teams, primarily basketball and indoor soccer. At the end of the study, 39.5% of students played sports, with most active in soccer and baseball or softball.

A strength of the present study is that students were randomly assigned to first- or second-semester physical education class enrollment without bias. In addition, we were able to access semester grades and standardized test scores of all study participants. The possible influence of socioeconomic status on the observed association between vigorous physical activity and academic achievement cannot be ruled out (12,13). A limitation of this study was the lack of data on socioeconomic status. This lack of information may lead to a misinterpretation of the data in the observed relationship between physical activity and academic achievement. It is possible that physical activity may be only a marker for greater levels of academic achievement and may not be a causal factor. It is important to note that socioeconomic status may be the major cause of academic performance (i.e., high socioeconomic status is responsible for high grades), with physical activity level acting as a mediator in this relationship. However, it is not



possible to determine the true cause because socioeconomic status data were not collected as part of the study. This fact should be considered when interpreting the results.

In summary, improved academic performance was associated with vigorous activity obtained outside of school in the present study. The findings suggest that a potential role may exist for vigorous activity in physical education classes. Although students did not perform better academically during the semester that they were enrolled in physical education,

the results indicate that they did not show a decrease in academic achievement compared with students who received an extra hour of academic instruction per day.

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