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Effects of Health-Related Physical Education on Academic Achievement: Project SPARK

James F. Sallis, Thomas L. McKenzie, Bohdan Kolody, Michael Lewis, Simon Marshall, and Paul Rosengard

The effects of a 2-year health-related school physical education program on standardized academic achievement scores was assessed in 759 children who completed Metropolitan Achievement Tests before and after the program. Schools were randomly assigned to condition: (a) Specialists taught the Sports, Play, and Active Recreation for Kids curriculum; (b) classroom teachers were trained to implement the curriculum; and (c) controls continued their usual programs. The Trained Teacher condition was superior to Control on Language, Reading, and Basic Battery. The Specialist condition was superior to Control on Reading, but inferior on Language. Despite devoting twice as many minutes per week to physical education as Controls, the health-related physical education program did not interfere with academic achievement. Health-related physical education may have favorable effects on students' academic achievement.

Key words: learning, physical activity, schools, children

Medical (American Academy of Pediatrics Committees on Sports Medicine and School Health, 1987) and public health (U.S. Public Health Service, 1991; Centers for Disease Control and Prevention, 1997) authorities recommend quality school physical education for all ages because of the documented health benefits of physical activity. Just as interest in improving health through physical activity is increasing (U.S. Department of Health and Human Services, 1996), participation in physical education is decreasing (Centers for Disease Control and Prevention, 1997). Because school administrators view physical education as reducing instruction time in core academic subjects, there is an historical resistance to physical education (Shephard, 1997). Physical educators are continually trying to justify the value of their work to avoid cuts or elimination of requirements and funding. One long-term strategy has been to claim that quality physical education will contribute to the academic and intellectual development of students. "Physical educators were grasping for ways to justify exercise and physical education programs. If it could be shown that activity programs contributed to intellectual development, then they would gain credibility and be justified" (Kirkendall, 1985, p. 59).

Numerous links between mind and body have been documented, and there are reasons to believe physical activity could aid learning (Jensen, 1998). Human and animal studies show brain areas involved in movement and learning are intimately connected, and physical activity could increase those neural connections (Jensen, 1998; Shephard, 1997). Learning complex movement sequences stimulates the prefrontal cortex used in learning and problem solving, and this effect could improve learning. Animal studies indicate that exercising rats have more neural connections, nourished by more capillaries, than sedentary rats (Jensen, 1998). Additionally, physical activity might alter arousal through neurohormonal mechanisms, which could improve the child's attention in the classroom (Shephard, 1997). Although

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the mechanisms for any effects are not known, a review of over 100 studies, mainly of adults, concluded that physical activity is associated with selected advantages in cognitive function, specifically math, acuity, and reaction time (Thomas, Landers, Salazar, & Etnier, 1994). On the other hand, Pellegrini and Smith (1995) concluded from a small number of studies of children that improved attention or cognitive performance was probably due to a break between tasks and not physical activity.

Many studies have been conducted on children to determine whether training in perceptual motor skills, such as balance and eye-hand coordination, improves academic and cognitive performance. A review of 180 controlled studies concluded that any effects on academic or intellectual functioning were very small and not commensurate with the time devoted to the training (Kavale & Mattson, 1983). Perceptual-motor training did not enhance performance on any subcomponent of cognitive functioning, so this hypothesis is now considered discredited (Thomas et al., 1994). However, physical education programs are very different from perceptual motor training programs.

Claims of the academic benefits of physical education have been made over decades, but they have been based on a shallow scientific foundation. An almost legendary study conducted in Vanves, France, in the 1950s is often referred to, but it has never been published in English. It has been described as an attempt to balance the intellectual and physical needs of children. In some schools, physical education time was increased to 8 hr per week, while academic instruction was reduced. Control schools maintained the traditional curriculum, and the evaluation continued over many years. In secondary sources, it has been reported that children in the experimental schools were superior in physical health, psychological health, and academic performance (Shephard, 1997). However, it is difficult to attribute any improvements to physical education, because the program also included daily naps and vitamin supplements. The methods and rigor of this study have been questioned (Shephard, 1997).

Another large and long-term study was conducted in Trois Rivieres, Quebec, Canada, beginning in the mid 1970s (Shephard, JeQuier, LaVallee, LeBarre, & Rajic, 1980; Shephard, LaVallee, Volle, LaBarre, & Beaucage, 1994; Shephard et al., 1984). Students in first through sixth grades received increased time for physical education and decreased time for other types of instruction. Controls were classes that preceded and followed the experimental cohort. Improvements were reported, not only in fitness and psychomotor abilities, but in class grades also. In addition, experimental students received higher grades on a standardized test of math, but there were no differences in other subject areas.

The latest evaluation of enhanced physical education occurred in 1978 in seven randomly assigned primary schools in South Australia (Dwyer, Coonan, Leitch, Hetzel, & Baghurst, 1983). The experimental group had 1 hr of physical education each school day, while the control group continued the usual curriculum, which included more academic instruction. Several improvements in physiological and fitness variables were reported, but there were no differences in academic grades. Two-year follow-up data indicated trends favoring the experimental students, regarding arithmetic and reading grades as well as beneficial effects on teachers' ratings of classroom behavior (Maynard, Coonan, Worsley, Dwyer, & Baghurst, 1987).

These three studies provide encouraging findings about the effects of enhanced physical education on academic performance. Two studies reported academic benefits, and one reported no difference, in spite of 14–26% reduction in instruction time for subjects other than physical education. However, these studies are far from definitive, and further investigation is needed to offer a stronger empirical basis for policies regarding physical education in schools. Only the South Australian study was randomized, and only the Trois Rivieres study used standardized tests. It is important to use standardized tests rather than teacher-assigned grades to assess academic achievement. The latter can be biased, especially if the teachers also instruct physical education. In the present study, a 2-year health-related physical education program was evaluated in a randomized study, whose primary results have already been reported (Sallis et al., 1997), and the effects on academic achievement were assessed with standardized tests.

Method

Experimental Design

The study was conducted in a single school district serving a relatively affluent suburb in Southern California. Of the 12 public elementary schools that agreed to participate in a randomized study of physical education, 7 were selected for the study. The total enrollment of these 7 K–5 schools ranged from 631 to 1,081. The percentage of ethnic minorities ranged from 10 to 19.

These schools were stratified by the percentage ethnic minorities and randomly assigned to one of three conditions. In the Specialist condition, certified physical education specialists implemented the Sports, Play, and Active Recreation for Kids (SPARK) program. Three specialists were hired by the research project to instruct students in two schools, and one Specialist was also the principal trainer for the Trained Teacher condition. In the Trained Teacher condition, classroom teachers were trained by research staff to implement the SPARK program. In the Control condition, classroom teachers

implemented the usual physical education program. Prior to the present study, no schools had physical education specialists on staff, and there was no specific physical education curriculum. There were two schools in each condition, but a third school was added to the control condition.

Participants

Informed consent was obtained from 98% of fourth grade students and their parents. Students were recruited at the beginning of 2 consecutive school years—1990 and 1991. These two cohorts are analyzed separately because of content changes and administration of the academic achievement test. At baseline, 1,538 students completed surveys and were considered participants in the main study. The ethnic distribution of participants was similar to the community, and there were no differences in gender or ethnic distribution by condition. There was a significant difference in age by condition ($p < .01$), but the range of means was only 9.49–9.62 years.

Cohort Retention. Students were assessed for physical activity, physical fitness, and psychosocial variables in the fall and spring of the fourth, fifth, and sixth grades. For analyses of physical activity and fitness outcomes at the end of fifth grade, cohort retention was 62.1% ($n = 955$) (Sallis et al., 1997). The retention rate was low, because students in the previous analyses were required to have relatively complete data over 2 years on multiple types of measures, including surveys, fitness tests, physical activity monitors, and parent surveys. The latter two measures resulted in a lower retention rate, according to the definition used. There were no differences in retention rates by experimental condition.

For the present analysis of achievement test outcomes, the study sample was defined as having achievement test scores in the fifth or sixth grades. Most of these students also had achievement test scores from the second grade, which was considered baseline. Second grade scores were not available for some students, because they were not in the district at that time or the records could not be retrieved. Therefore, second grade scores for 85 students in Cohort 1 and 106 students in Cohort 2 were assigned sex- and school-specific means. The final sample size was $n = 330$ in Cohort 1 and $n = 424$ in Cohort 2. This represents 49% of the original baseline sample and 79% of the sample used to evaluate physical activity and fitness outcomes (Sallis et al., 1997). Achievement test records were not available from one school, which accounts for most of the reduced sample size.

Achievement test data were available at posttest for 754 students, while an additional 387 students had some post-test data but not achievement test scores. Table 1 shows the comparison of students with and without achievement test data, to assess the extent to which the achievement test sample is representative of the entire sample. There were no differences on gender or ethnic group. However, students in the achievement test sample were, on average, 0.1 years older than the remaining students in the study sample, which was a significant difference ($p < .01$). In addition, parents of students in the achievement test sample had significantly higher educational levels ($p < .02$).

The SPARK Program

SPARK is a comprehensive curriculum and professional development program designed to promote physical activity in and out of school. The program is taught throughout the fourth and fifth grades. The physical education curriculum teaches activity skills and provides physical activity for all students during class. The self-management curriculum promotes physical activity outside of school. The professional development program trains classroom teachers in the Trained Teacher condition to implement the two curricula for their students.

Physical Education Program. SPARK physical education classes are designed to promote high levels of physical activity that will improve health-related fitness, promote movement skills that add to success and enjoyment in physical activity, and encourage positive socialization. The curriculum calls for classes to be taught a minimum of 3 days a week throughout the school year (36 weeks). The yearly plan is divided into instructional units typically 4 weeks (12 lessons) in length. A standard SPARK lesson lasts 30 min and has two parts: a health-fitness activity (15 min) and a skill-fitness activity (15 min).

Table 1. Comparison of demographic variables for students with and without achievement test data

Variable	Achievement test sample ($n = 754$)		Not in achievement test ($n = 387$)		Chi-square or *t* test	*p* value
	M	*SD*	*M*	*SD*		
Sex (% female)	47.8		47.4		0.01	.91
Ethnicity					7.87	.17
% European American	78.7		84.5			
% Asian/Pacific Islander	14.2		10.4			
% Latino	4.9		3.2			
% African American	2.2		1.9			
Parent education					10.01	.02
% ≤ 12 years	18.1		25.0			
% ≤ 13–15 years	19.5		23.1			
% 16 years	36.7		31.8			
% ≥17 years	25.7		20.1			
Age at baseline (years)	9.5	.43	9.6	.52	2.72	.04

In the health-fitness segment, there are 13 activity units, including aerobic dance, running games, and jump rope. Progression is developed by modifying the intensity, duration, and complexity of the activities. Although the main focus is on developing cardiovascular endurance, activities to develop abdominal and upper body strength are included.

The sport-fitness part of the lesson includes nine sports units that have the most potential for promoting cardiovascular fitness and for generalizing to the child's community (e.g., soccer, basketball, Frisbee games). Popular but low-active games, such as softball and kickball, were modified to make them more active.

Self-Management Program. The purpose of the self-management program is to teach students behavior change skills believed to be important in the generalization and maintenance of regular physical activity. The emphasis is on teaching behavior change skills rather than teaching knowledge related to physical activity. Self-management skills and related topics are taught in weekly 30-min classroom sessions. The sessions are guided by scripted curricula, comprising approximately 32 sessions each for fourth and fifth grade students.

Each session begins with a brief review of the skills or information presented during the previous session and a discussion of the students' progress on activity goals during the previous week. Approximately 15–20 min are spent on the presentation of a new topic. Students usually spend much of this time working in small groups or playing games designed to convey the information and provide them with practice using the targeted skills. At the end of the class, students set physical activity goals for the coming week. Students are awarded prizes (e.g., pencils, sports water bottles) for meeting weekly activity goals. The reward system continues throughout most of the fourth grade and is faded out approximately halfway through the fifth grade.

Family involvement is strongly encouraged. A parent's signature is required on each goal sheet for students to receive activity points, and homework assignments require family participation. Students can receive extra points for involving family members in their physical activity. Monthly newsletters encourage family participation in the student's physical activity program.

Classroom Teacher Professional Development Program. The professional development program was designed to develop teachers' class management and instructional skills so they could implement the physical education and self-management curricula effectively. Trainers described and modeled all teaching techniques, teachers practiced physical activities and teaching methods, and trainers provided praise and corrective feedback. During each training session teachers were assisted in planning a personal program of regular physical activity. Professional development sessions were extensive, with 11 sessions (32 hr) held during the first year. About 70% of the time was allocated to the physical education curriculum, and 30% was allocated to the self-management curriculum. A mean satisfaction score of 4.83 on a 5-point scale indicated teachers evaluated the sessions very highly.

In addition to the group inservice sessions, follow-up support was provided at school sites, where the consulting physical education specialist led grade-level planning meetings, modeled lesson segments, coordinated space and equipment use, assisted with class scheduling, and gave verbal and written feedback to teachers after observing their lessons.

Physical Education Specialists. Three specialists implemented physical education and self-management curricula in two schools. They received ongoing training and supervision from the investigators, and their teaching quality was monitored and enhanced by regularly viewing videotapes of physical education and self-management classes.

Control Condition. Control schools were asked to continue with the usual physical education program and requested not to begin new physical education initiatives during the study. These schools did not follow any specific physical education curriculum. All schools, including control schools were provided with sufficient equipment and supplies to implement the SPARK physical education program.

Measure of Academic Achievement

Academic achievement was measured using Metropolitan Achievement Tests (MAT6 and MAT7; Psychological Testing Corporation, 1990), which are widely used in the United States. The MAT6 and MAT7 are norm-referenced tests that provide scores for reading, mathematics, language, and a composite score known as the Basic Battery. Each of the three segments of the test takes 85–90 min to complete, and the items are multiple choice. The tests are administered by classroom teachers and machine-scored by the testing company. Scores are reported as national percentile rankings. Data records were retrieved from schools and district offices.

The tests and timing of administration were chosen by the district administration. For Cohort 1 the MAT6 was administered in the spring of the second and fifth grades. For Cohort 2 the MAT6 was administered in the spring of the second grade. Then the MAT7 was introduced, and it was administered in the district for the first time in the fall of the sixth grade for the second cohort. Personal communication with staff from the Psychological Testing Corporation revealed that scores from the MAT6 and MAT7 tests were not directly comparable.

Analysis

For all analyses, Cohorts 1 and 2 were analyzed separately, because the version and the timing of the posttests

were different. Individual students were the unit of analysis. Meaningful analytic adjustment for school cluster effects was precluded, because second grade (baseline) achievement scores were not available for students who transferred into SPARK schools. Sex-specific baseline school means were substituted for missing baseline scores for 191 students.

Analysis proceeded hierarchically through several steps. In the first stage, posttest achievement scores were regressed on baseline scores, sex, dummy variables for experimental modality, and all possible interaction terms. No baseline achievement by modality interaction approached statistical significance. A significant sex by modality interaction was found in only one of the eight tests; therefore, a simple one-way analysis of covariance (ANCOVA) with baseline achievement as the covariate and experimental modality as the grouping variable (degrees of freedom = 2) was used as the next test. Inasmuch as these ANCOVAs produced the same conclusions as simple one-way analyses of variance (ANOVAs) of baseline to posttest difference or change scores, the latter was chosen as the most simple presentation method for the tests, and results appear in Tables 2 and 3. The tables show means and standard deviations for baseline (second grade), posttest (fifth grade for Cohort 1 and sixth grade for Cohort 2), and difference or change scores. Also given are the ANOVA test *F* values (degrees of freedom = 2) and probabilities. Significant ANOVA outcomes were further analyzed with Student-Newman-Keuls adjusted pairwise comparisons of the experimental modalities.

Results

Tables 2 and 3 show that achievement test scores greatly exceeded the national average at baseline (range: 58.5–80.9). There were declines from the second grade to the fifth or sixth grade in percentile rankings of all achievement test scores in all experimental conditions, with one exception. Nevertheless, significant differences among experimental conditions were detected.

Table 2 shows no effects of the SPARK intervention on the Basic Battery or Math score for Cohort 1. On the Language score, the decline in percentile ranking was significantly less in the Trained Teacher condition than in the Control condition. On the Reading score, students in the Specialist condition increased in percentile ranking while the Control students declined, and this difference was significant.

Table 3 shows significant intervention effects on three of the four scores for Cohort 2. On the Basic Battery and Reading scores, students in the Trained Teacher condition declined less than those in the other two conditions. The only negative effect was on the Language score, for which declines in the Specialist condition were significantly greater than in the other two conditions.

Table 2. Baseline and change scores in academic achievement percentiles, by experimental condition, for Cohort 1

Achievement test variable and experimental condition	Percentile score, 2nd grade		Percentile score, 5th grade		Raw difference score (5th–2nd grade)		*F, p*	Pairwise comparisons
	M	*SD*	*M*	*SD*	*M*	*SD*		
Basic battery							1.44, .24	NS
Specialist	66.7	23.3	64.7	25.9	-2.0	18.7		
Trained Teacher	77.1	18.3	73.9	22.8	-3.1	17.2		
Control	77.4	18.7	71.4	21.9	-6.0	16.4		
Language							3.37, .04	T < C
Specialist	63.6	22.3	57.7	25.4	-5.9	20.1		
Trained Teacher	72.8	19.2	71.3	22.0	-1.5	18.8		
Control	74.9	18.6	67.5	23.5	-7.4	19.5		
Mathematics							.01, .99	NS
Specialist	74.2	23.6	68.1	27.0	-6.1	22.3		
Trained Teacher	78.1	18.0	72.3	25.4	-5.8	22.3		
Control	79.7	18.2	73.9	23.1	-5.8	23.1		
Reading							4.29, .02	S > C
Specialist	58.5	23.4	63.4	26.8	4.9	21.6		
Trained Teacher	71.6	19.9	71.4	22.5	-0.1	18.4		
Control	70.1	20.7	66.5	24.3	-3.7	17.6		

Note. Numbers of participants by condition: Specialist = 59; Trained Teacher = 147; Control = 124; Total = 330. For all one-way analyses of variance, degrees of freedom = 2. *M* = mean; *SD* = standard deviation; NS = not significant; S = Specialist condition; T = Trained Teacher condition; C = Control condition.

Discussion

The primary finding is that spending more time in physical education did not have harmful effects on standardized academic achievement test scores in elementary school children. There was some evidence that a 2-year health-related physical education program had several significant favorable effects on academic achievement. However, the significant intervention effects were not improvements in academic achievement scores; results indicated smaller declines than controls. In virtually all scores in both cohorts, there were decreases in achievement test percentile scores from baseline to posttest. Because this occurred in all conditions, the decline was not due to the physical education program. This study was conducted in a relatively affluent suburb, and it can be seen from the percentile scores that this is a high-achieving district. The high baseline levels may account for the overall decline in scores from the second through the fifth grades in a regression-to-the-mean effect. Studies of health-related physical education need to be conducted in school districts with lower baseline achievement test scores to determine whether physical education can improve achievement rankings.

Four of eight statistical comparisons showed an advantage for students in experimental conditions. Only one of eight comparisons showed that control students had an advantage. Significant intervention effects were replicated in two cohorts, indicating the effects generalized across different forms of the test and different administration times. These findings dispute the concerns of school administrators that spending more time on physical education will interfere with academic performance (Shephard, 1997).

Direct observations of physical education and self-management classes revealed that Trained Teachers and Specialists spent much more time in physical education than Control teachers. Actual time spent in physical education classes in a typical week were 38 min for Controls, 65 min for Trained Teachers, and 80 min for Specialists (Sallis, et al., 1997). Time spent per week in self-management classes were 0 min for Controls, 27 min for Trained Teachers, and 29 min for Specialists. Compared to the time Controls spent in physical education (38 min), Trained Teachers spent 241% (92 min) more, and the Specialists spent 286% (109 min) more per week. Over 2 academic years (assuming 32 weeks of physical education), it appears that Trained Teachers and Specialists spend 57 and 76 hr less time, respectively, teaching other academic subjects, without harming academic achievement. The present study supports the contentions of physical educators that children who are more active and physically fit may be better learners as well (Kirkendall, 1985).

Training classroom teachers to improve their teaching of physical education appears to have generalized positive effects on student academic achievement. On three scales and in both cohorts, students in the Trained Teacher condition performed better than students in the

Table 3. Baseline and change scores in academic achievement percentiles, by experimental condition, for Cohort 2

Achievement test variable and experimental condition	Percentile score, 2nd grade		Percentile score, 6th grade		Raw difference score (6th–2nd grade)		*F, p*	Pairwise comparisons
	M	*SD*	*M*	*SD*	*M*	*SD*		
Basic battery							7.23, .001	T < S,C
Specialist	75.0	21.8	57.7	26.7	-17.3	18.1		
Trained Teacher	75.2	20.6	66.1	25.6	-9.0	18.6		
Control	77.2	19.6	61.3	27.1	-15.9	22.9		
Language							5.8, .004	T,C < S
Specialist	72.7	21.9	54.7	27.1	-18.0	21.0		
Trained Teacher	73.1	20.2	64.4	26.1	-8.7	23.5		
Control	70.7	20.9	59.6	27.9	-11.1	24.0		
Mathematics							2.72, .07	NS
Specialist	75.7	21.9	53.9	28.5	-21.8	25.2		
Trained Teacher	78.2	19.4	61.9	28.0	-16.4	22.0		
Control	80.9	18.8	58.6	28.0	-22.3	27.6		
Reading							8.36, .001	T < C,S
Specialist	75.7	21.9	53.9	28.5	-21.8	25.2		
Trained Teacher	78.2	19.4	61.9	28.0	-16.3	22.0		
Control	80.9	18.8	58.6	28.0	-22.3	27.6		

Note. Numbers of participants by condition: Specialist = 118; Trained Teacher = 165; Control = 141; Total = 424. For all one-way analyses of variance, degrees of freedom = 2. *M* = mean; *SD* = standard deviation; NS = not significant; S = Specialist condition; T = Trained Teacher condition; C = Control condition.

Control condition. However, there was no achievement test score on which the Trained Teacher advantage was documented in both cohorts. This pattern of results supports an interpretation that training classroom teachers to improve their physical education classes has favorable effects on academic achievement and are not limited to a single subject area. The lack of consistency in effects on specific scores could be related to the change in the version and timing of the achievement tests.

There was no convincing evidence that the Specialist condition had favorable effects on students' academic achievement. On six of eight comparisons, scores for the Specialist condition were no different from those for the Control condition. For the Language test in Cohort 2, scores declined *more* in the Specialist condition than in the other two conditions. However, the strongest favorable effect in the study was also observed for the Specialist condition. In Cohort 1, the Reading percentile score increased for the Specialist condition and decreased for students in the Control condition. The most likely explanation of these observed inconsistencies is the change in test version and timing. A possible explanation for the general lack of favorable outcomes in the Specialist condition is that the two schools in this condition had the lowest baseline achievement test scores (see Table 2). This may have been due to the relatively lower socioeconomic status of these schools, making it more difficult to improve achievement scores. Overall, there is little evidence that the Specialist condition had beneficial effects on academic achievement. There is also little evidence that the Specialist condition had a detrimental effect, although this condition devoted the most time to physical education.

This pattern of scores calls into question the hypothesis that student physical activity alone enhances academic performance, which is the basis for most of the presumed mechanisms of physical education's effects (Jensen, 1998; Shephard, 1997). In previously reported analyses from the main study, the Trained Teacher condition was shown to increase student physical activity in physical education classes, but physical education Specialists improved significantly more (Sallis, et al., 1997). It was expected that academic achievement would be enhanced most in the Specialist condition because of the larger effects on physical activity. The Pellegrini and Smith (1995) hypothesis that breaks from academic tasks improve attention was also not supported, because both intervention conditions had more physical activity breaks than controls. The present study supports an alternative hypothesis that unidentified factors associated with training classroom teachers to improve their teaching of physical education led to better academic performance. Perhaps learning ways to manage children in the physical education setting or increasing confidence in teaching physical education can improve the teaching of academic subjects. Further studies are needed to replicate this effect and identify mechanisms whereby improving the ability of classroom teachers to teach physical education might lead to better student academic performance. Additional basic research is needed to clarify the effects of different types and amounts of physical activity on brain structure and function (Jensen, 1998; Shephard, 1997) and to understand how to design physical education programs that maximize any beneficial effects on learning and cognitive performance.

The results of the present study are generally consistent with the three other studies that have investigated the effect of an enhanced physical education curriculum on academic performance (Shephard, 1997). None of these four studies showed that devoting increased time to physical education harmed academic performance.

There is one area in which the results of the present study disagree with previous findings. The Canadian (Shephard et al., 1994) and Australian (Maynard et al., 1987) studies reported improvements in math performance in experimental students. In addition, correlational studies showed that physical activity is positively associated with math performance (Thomas et al., 1994). In the present study, Math was the only score that did not show any evidence of an experimental effect. This discrepancy provides evidence that the increased physical activity in the SPARK physical education program was not the mechanism for favorable effects on academic achievement. Reading, language, and the summary score were all favorably affected by the Trained Teacher condition in the present study. Discrepancies from previous physical education studies may be due to differences in tests. It is especially difficult to compare present results to those of the Australian study (Maynard et al., 1987), because the latter used only school grades, not standardized tests. Further studies are needed to determine which academic achievement test scores are most affected by quality physical education.

The strengths of the present study include the randomization of schools to condition in a controlled field trial, application of a standardized health-related physical education program, the comparison of Trained Teachers and Specialists teaching the physical education curricula, availability of baseline and posttest measures, replication of analyses across two cohorts, and use of a standardized academic achievement test. In one sense, the change in the version and the timing of the test from Cohort 1 to Cohort 2 is a weakness of the study. These changes were dictated by the school district and were out of the control of the investigators. However, these changes were also a strength, because separate analyses for the two cohorts showed a replication of favorable effects. Although splitting the sample decreased the statistical power to detect differences between conditions, significant differences were found for both cohorts.

The present study provides strong evidence that devoting substantially increased school time to health-re-

lated physical education does not have detrimental effects on students' academic achievement. The present results reinforce previous findings that spending more time on physical education does not interfere with academic performance. School administrators are encouraged to provide health-related physical education programs, because physical activity confers physical and mental health benefits to students (Sallis, 1994).

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