JOURNAL OF SCHOOL HEALTH

American School Health Association

RESEARCH ARTICLE

The Impact of a Physical Activity Intervention Program on Academic Achievement in a Swedish Elementary School Setting

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ABSTRACT

BACKGROUND: Despite the emerging body of research on the potential of physical activity to improve learning and academic achievement, conclusive evidence regarding the effects of physical activity on academic achievement is lacking. The objective of this study was to determine the impact of a physical activity intervention program on academic performance.

METHODS: A controlled cross-sectional design was used to investigate the hypothesis that the intervention program would increase the proportion of students in grade 5 who achieved the national learning goals in Swedish, mathematics, and English compared with 3 reference schools. Academic results from the years prior to and during the intervention program were analyzed. Logistic regression analyses assessed the odds of achieving the national learning goals when the intervention program was integrated into the elementary curricula.

RESULTS: Higher proportions of students in the intervention school achieved the national goals in all 3 subjects compared with the reference schools after initiation of the intervention program. The odds for achieving the national learning goals in the intervention school increased 2-fold ($p < .05$), whereas these odds either did not change or decreased in the reference schools.

CONCLUSION: Promoting physical activity in school by means of a curriculum-based intervention program may improve children's educational outcome.

Keywords: exercise; educational outcome; school-based; intervention; children.

Citation: Käll LB, Nilsson M, Lindén T. The impact of a physical activity intervention program on academic achievement in a Swedish elementary school setting. J Sch Health. 2014; 84: 473-480.

Received on May 28, 2013
Accepted on November 26, 2013

The benefits of physical exercise during childhood are widely recognized and span many physical and mental health domains.[1,2] Childhood and adolescence are critical periods for the acquisition of healthy lifestyles and the school environment is an important arena for such development.[3] However, there is a global tendency toward cutbacks in physical education classes.[4,5] In Sweden, the time allocated for physical education has been reduced drastically due to constraints and changes in the curriculum of the national school system. In addition, cumulative evidence demonstrates that a significant decline in general levels of physical activity occurs during early adolescence.[6] This finding is of particular concern because it is known that physical activity habits developed during childhood are retained in the transition to adulthood. Interventions that support

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Funding for this study was provided by the Swedish Brain Foundation, Sten A Olsson's Foundation for Research and Culture, Swedish National Centre for Research in Sports, and the Kempe Carlgrenska Foundation.

and provide opportunities and motivation for young people to be physically active could help to address this problem.

School-based exercise programs have been shown to have a favorable effect on children's health by improving their total activity level, physical fitness, body composition, bone mass, and insulin sensitivity and have also been shown to reduce markers of inflammation.[7-10] Exercise has been reported to be associated with markers of psychosocial well-being, such as physical self-perceptions and self-esteem in children.[11,12] There is a burgeoning interest in the benefits of fitness and physical activity to cognition and learning.[13,14] The potential for different types of physical activity to promote and develop cognitive functions such as concentration and memory processing and subsequent school achievement is of utmost interest to both researchers and society.[15]

Academic achievement is often quantified as a student's achievement in a particular subject as assessed by standardized national assessment tests within a school or educational setting. Apart from individual learning ability, achievement in school is highly associated with socioeconomic (SE) factors, such as home background and environment.[16,17] The Swedish school system is goal-directed. In the former National Curriculum for compulsory school in Sweden, Lpo94, 2 types of scholastic goals were formulated: ''Goals to achieve'' and ''Goals to strive toward.'' ''Goals to achieve'' describe the minimum levels that the students should have achieved by the time they leave school. ''Goals to strive toward'' specify the orientation of the work in the school. Starting in 1994, national tests in Swedish, mathematics, and English have been conducted in grade 5. The tests are given to ensure equal and fair assessment and were voluntary until the end of 2008 but have been obligatory in the years thereafter. With guidance from the results of the national test, teachers make a collective assessment of the students' knowledge in relation to the goals. The national tests are also the basis for school planning and national comparisons.

Evidence that physical activity and academic achievement are associated is accumulating.[4,5,10,18-26] However, controlled intervention studies exploring the role of physical activity in school children are relatively scarce.[27,28] In addition, the results from previous studies are not consistent and do not provide sufficient evidence to conclude solidly that increased physical activity improves academic achievement.[15,29] The aim of this study was to determine the impact of a school-based physical activity intervention protocol (''School in Motion'') on academic achievement in children. We hypothesized that the increased level of curriculum-based physical activity would be positively correlated with academic achievement in the intervention school.

METHODS

Participants and Setting

The ''School in Motion'' intervention program was initiated in 2004 in the city of Mölndal, Sweden, and involved a local sports club and selected elementary schools. The intervention program was designed to promote a physically active lifestyle among the attending school children. Increased, regularly scheduled physical activity was introduced into the school selected for the study via 2 weekly physical activity classes conducted by the local sports club introduced into the otherwise unchanged schedules of all students in the school (from preschool class to grade 6). This manipulation nearly doubled the amount of school-based physical activity in the intervention school.

Three other schools in the same region with SE characteristics similar to the intervention school were selected to serve as a reference group. The selection of schools was guided by previous studies indicating that SE variables, such as level of education and foreign origin/citizenship, appear to have the greatest influence on educational outcome. In both the intervention and reference schools, the standard physical education curriculum (2 weekly classes) was unchanged during the intervention period.

Procedure

The additional physical activity in the intervention group was introduced as a part of a Swedish government program (Handslaget). This program fulfilled an agreement with the Swedish Sports Confederation to engage local sports clubs to involve more children in organized sport activities. All students in the intervention school were involved in presumably joyful physical activities led by local sports club instructors who visited the school from the spring semester of 2004 onward. The physical activity sessions were planned and introduced by professional staff members from the local sports club. These sessions included twice a week ''play and motion'' activities that were completed in addition to the 2 hours of curricular physical activity. The activities lasted for 30-45 minutes and were designed to be engaging, enjoyable, health promoting, and noncompetitive; the activities consisted of different sports and games with or without the use of equipment. These extra hours of physical activity were scheduled and mandatory for all children. Additionally, the local sports club also arranged voluntary additional activities, such as soccer in the afternoon after school, and different play activities available during the spring, Easter, and winter holidays.

Design

A controlled cross-sectional design that takes advantage of historical data was used to investigate

the hypothesis that the school-based physical activity intervention program would increase the proportion of students in grade 5 who achieved the national goals in Swedish, mathematics, and English compared with a reference group.

Measures of Academic Achievement

The result of the intervention was assessed by analysis of the children's academic achievement during the 4-year period before and 5-year period after the start of the ''School in Motion'' intervention. The outcome measure was defined as the odds of achieving the national goals when a physical activity intervention program was integrated into the elementary curricula.

Data Collection

Academic school results from the period of 2000-2008 were extracted from the Regional Childcare and Educational Department and included 408 students from the intervention school and 1557 students from the reference schools. The obtained data sets were made anonymous; thus, consent from the parents or guardians was not needed. Academic achievement and sex distributions within all schools were extracted from the Regional Childcare and Educational Department. Socioeconomic data from the years 2000 and 2008 were obtained from Statistics Sweden.

Data Analyses

Socioeconomic data were analyzed to investigate whether there were any changes in SE characteristics within the schools' catchment areas during the study period. Socioeconomic characteristics were calculated in relation to the region, and the SE data for the 3 reference schools were aggregated. Changes in SE factors during 2000-2008 in relation to the index of the region were calculated; these changes included level of education, foreign citizenship and foreign born, un/employment, and average income. The proportions of students in grade 5 who achieved the national goals in Swedish, mathematics, and English between the years 2000 and 2003 (before the start of the intervention program) and between the years 2004 and 2008 (after the start of the intervention program) were aggregated and presented. The proportion of girls was calculated and compared between the intervention and reference schools using the chi-square test. Logistic regression was used to explore the relationship between school affiliation and academic achievement, ie to discriminate between those who achieved the national goals and those who did not. Odds ratios (ORs) and corresponding confidence intervals were estimated. A factor that combined school and period in which period 2 (the period after the intervention) for the reference school was set as the reference category and derived and analyzed, and subsequent results from the logistic regression analysis revealed an OR = 1.0.

The presence of a statistical significant interaction effect shows that there is not a constant OR for the academic achievement comparing subjects in the interventions schools and control schools by difference between the 2 periods. If a presence of such effect was statistically demonstrated, we have estimated the odds for the combination of school and period, where control school of period 2 was set as the reference, having an odds = 1.0. An OR > 1 indicates increased odds for academic achievement and <1, decreased odds.

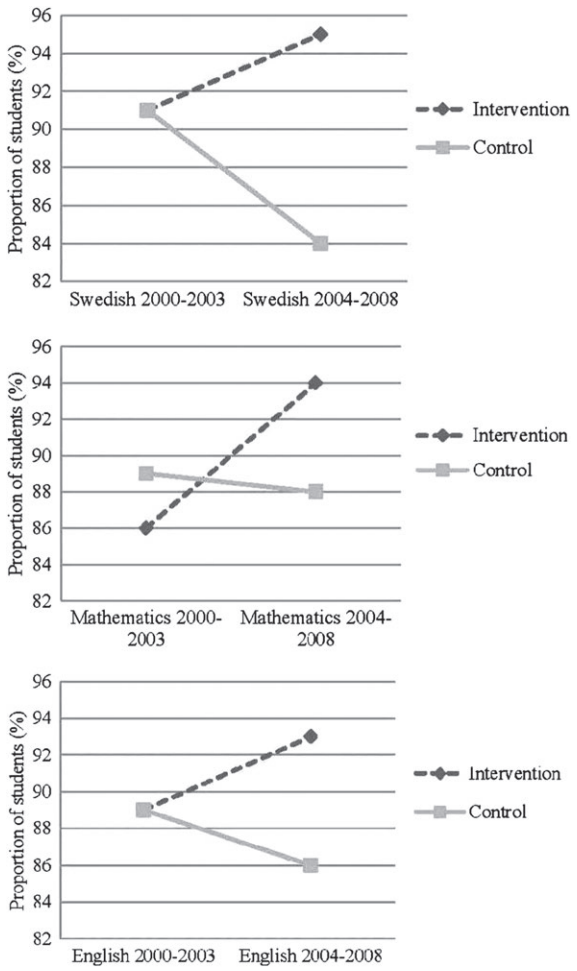
Analyses were performed using the Statistical Package for Social Sciences (SPSS 16.0; IBM Inc., Chicago, IL). All tests were 2-tailed with a criterion for statistical significance of $p < .05$.

RESULTS

Even though the national tests were voluntary prior to 2008, few students in the schools did not take the tests during this period. In the 4-year period prior to the start of the intervention program, 99.0% of the intervention school students and 99.6% of the reference schools students took the national tests. During the intervention period of 2004-2008, there were a total of 196 students in grade 5 in the intervention school who participated in the intervention program, and all of these students took the national tests. In the reference schools, 99.3% took the national tests in mathematics, and 99.0% took the tests in Swedish and English. The proportions of students who achieved the national goals in Swedish, mathematics, and English before and after the start of the intervention program are illustrated in Figure 1. Between the years 2000 and 2003 the accumulated proportion of girls in the intervention and control school was 47% and 50%, respectively. Between the years 2004 and 2008 the accumulate proportion was 46% and 51%, respectively. No sex differences were observed between the groups at any of the time points ($p = .67$ and $p = .48$ respectively). The SE characteristics of the intervention and reference schools' catchment areas in relation to the indices of the regions for years 2000 and 2008 and the change between the 2 time points within each region are presented in Table 1. In the majority of the SE variables, the differences between the 2 groups decreased between the years 2000 and 2008.

The results of the logistic regression analyses are presented in Tables 2-4 and reveal a statistically significant interaction effect between period and school on the odds for achieving the national goals in Swedish ($p < .001$), mathematics ($p = .037$), and English ($p = .042$). Table 3 shows comparisons of odds to the control schools at period 1 (OR = 1.0). Overall,

Figure 1. **The Proportion of Students in Grade 5 Who Reached the ''Goals to Be Achieved'' in Swedish, Mathematics, and English by Type of School, Treatment (Intervention or Control), and Time (Before and After the Start of the ''School in Motion'' Intervention Program in 2004)**



the odds for achieving the national goals increased from period 1 to period 2 for the subjects attending the intervention school ($p < .05$). During the same period, no significant change in the odds for achieving the national goals in English ($p = .50$) in the reference schools was observed. In mathematics, a trend toward a decrease in the odds for achieving the national goals was observed ($p = .08$) in the reference schools, whereas in Swedish, a significant decrease ($p < .001$) was demonstrated.

DISCUSSION

The results of this study showed that a school-based physical activity intervention program designed to make students more physically active during the school day significantly improved the children's academic achievement. Because this program is part of a unique political commitment, it is difficult to find comparable research in the literature. However, our findings are in line with those of other previous studies,[4,5,10,18-26] and thus, contribute to the body of evidence for a link between exercise and learning.

Because time devoted to physical activity could instead be time devoted to academic work, physical education is sometimes seen as a competitor of academic studies. One could question whether school-based physical activity is provided at the expense of time dedicated to academic learning. However, previous studies have demonstrated that increases in time spent in physical education are not likely to detract from students' academic effort.[5,30,31] At the time of our study, the intervention school did not have a regulated time plan, and the play and motion activities did replace some academic time. Only a little extra time for some classes was added to the ordinary schedule.

This study has strengths and limitations. Most previous studies have been cross-sectional and did not control for bias.[18,29,31-34] The most important strength of our study is the cross-sectional design, which increases the validity of the association between physical activity level and academic achievement in the present study. Furthermore, the physical activity intervention was directed at the entire school population and was scheduled and obligatory, which ensured that as many students as possible took part in the activities during the school day and that selection bias in the intervention group was avoided. Another important strength is that our study presents baseline academic achievement data during the 4-year period prior to the intervention. The data show that before the start of the intervention program, there were no differences between the intervention school and reference schools in the proportions of students who reached the ''goals to be achieved'' in any of the 3 subjects. Moreover, the intervention school had the same principal between the years of 2000 and 2008, and during that period, there were no other environmental or health-promoting changes made in the intervention school.

Other studies have utilized measures of academic achievement that include, for example, grade point average, scores on standardized tests, and grades in specific courses.[35] As an indicator of academic achievement in the present study we used ''goals to be achieved,'' which are based on standard national tests, to reduce the potential for rater bias. Only a small number of students did not take the national tests during the study period; otherwise, the number of students who took the test may hypothetically have affected the validity of the results observed.

The extended physical activity in school may have enhanced student's concentration and classroom behavior in the present study, which may have positively contributed to their academic achievement.

Table 1. **Socioeconomic Characteristics of the Intervention and Control Schools' Catchment Areas in Relation to the Indices of the Region for the Years 2000 and 2008 and the Changes Within Each Region Between the 2 Time Points**

Socioeconomic Variable	Region	2000	2008	Difference 2008−2000
Primary and lower secondary education	Intervention	104	98	−6
	Control	111	111	0
	Index	100	100	0
Upper secondary education ≤ 2 years	Intervention	86	90	4
	Control	110	108	−2
	Index	100	100	0
Upper secondary education > 2 years	Intervention	109	102	−7
	Control	99	104	5
	Index	100	100	0
Postsecondary education < 3 years	Intervention	112	116	4
	Control	98	101	3
	Index	100	100	0
Postsecondary education ≥ 3 years	Intervention	97	96	−1
	Control	79	85	6
	Index	100	100	0
Employed 20-64 years	Intervention	100	98	−2
	Control	98	99	1
	Index	100	100	0
Unemployed	Intervention	85	91	6
	Control	110	106	−4
	Index	100	100	0
Average income (salary)	Intervention	108	104	−4
	Control	94	95	1
	Index	100	100	0
Foreign citizen	Intervention	106	105	−1
	Control	105	106	1
	Index	100	100	0
Foreign born	Intervention	106	104	−2
	Control	108	108	0
	Index	100	100	0

Table 2. **Logistic Regression Analyses Using School Affiliation and Period as Independent Variables and Academic Achievement in Swedish as Dependent Factors**

Group/Period	p Value	OR	95% CI for OR	
			Lower	Upper
	<.001			
Intervention p1	.013	1.871	1.138	3.077
Intervention p2	.000	3.626	1.868	7.038
Control p1	.000	1.791	1.321	2.428
Control p2 (rc)		1.000		

OR, odds ratio; CI, confidence interval; p1, period 2000-2003; p2, 2004-2008; rc, reference category.

Table 3. **Logistic Regression Analyses Using School Affiliation and Period as Independent Variables and Academic Achievement in Swedish as Dependent Factors**

Group/Period	p Value	OR	95% CI for OR	
			Lower	Upper
	.037			
Intervention p1	.206	1.360	0.845	2.189
Intervention p2	.009	2.151	1.206	3.836
Control p1	.085	1.302	0.964	1.758
Control p2 (rc)		1.000		

OR, odds ratio; CI, confidence interval; p1, period 2000-2003; p2, 2004-2008; rc, reference category.

Physical activity might also improve mental health and self-efficacy[36,37] and alleviate stress, which in turn may affect school achievement. Additionally, the sports club instructors who arranged enjoyable and noncompetitive physical activities in the present study might have inspired the children and might have added to the joyousness, fellowship, and companionship in school; this may have in turn affected the students' mood and comfort with their school work. Furthermore, the extended hours of physical activity could have resulted in increasing the teachers' expectations regarding the children's learning potential and motivation toward schoolwork and perhaps resulted in increases in the amount of encouragement the teachers gave the students. The author of a previous study[38] suggested that increased physical activity during the school day may induce arousal and reduce boredom, which may result in increased concentration and an increased attention span. A more motivating school environment may

Table 4. **Logistic Regression Analyses Using School Affiliation and Period as Independent Variables and Academic Achievement in Swedish as Dependent Factors**

Group/Period	p Value	OR	95% CI for OR	
			Lower	Upper
	.042			
Intervention p1	.389	0.824	0.530	1.281
Intervention p2	.012	2.284	1.199	4.351
Control p1	.504	1.113	0.814	1.522
Control p2 (rc)		1.000		

OR, odds ratio; CI, confidence interval; p1, period 2000-2003; p2, period 2004-2008; rc, reference category.

have encouraged the students in the present study to engage more fully in schoolwork and may have thus been a mediating factor contributing to the results observed. However, all these effects may also have been the result of the intervention having a direct or indirect impact on the children's academic achievement. Biological effects, such as increased cerebral blood flow and angiogenesis (a primer for neuronal plasticity), may also have contributed to enhancements of the prerequisites for learning. In combination or separately, these mechanisms may be the underlying factors mediating the link between exercise and academic achievement. The literature provides evidence that fitness and exercise may boost brain function and cognition.[23,39,40]

It is well known that SE factors, such as ethnicity and parental education, influence children's achievement in school;[17,41] therefore, the SE characteristics of all of the schools' catchment areas in the region were examined to find the best possible matches for the intervention school. Because SE disadvantages affect school achievement, SE data from the years 2000 and 2008 were obtained and analyzed. Because the differences between the 2 groups in the majority of the SE variables decreased between the years 2000 and 2008, the possibility that changes in SE characteristics are an explanatory factor for the link between exercise and academic achievement can be ruled out. The fact that no sex differences were demonstrated further strengthens the credibility of the results and suggests that the demonstrated improvement in academic achievement within the intervention school was linked to the implementation of the physical activity intervention program. However, future high-quality research in this field and into the explanatory mechanisms and the dosage relationship between physical activity and academic achievement is needed.

Limitations

There are some limitations in the present study that should be considered. Our findings cannot explicitly illuminate the mechanisms that link exercise and academic achievement. There are potential mechanisms that may explain this relationship as discussed above. The fact that only 1 intervention school was included may make the results less representative; however, the SE characteristics of the school's catchment area were similar to that of the whole region and reference schools, indicating that the study group was a representative sample of the region. Three schools were selected to serve as a reference group instead of a single school to minimize the risk of selection bias.

Confounding factors, such as uneven distributions of unmeasured variables, including sex, fitness, and mental and psychological health among the school children may have affected the results of the present study; these variables could potentially have been responsible for the observed differences in that they could have produced a cluster effect. Because these distributions were extracted anonymously in an aggregated format, there was no possibility to control for sex in the regression analysis. However, no sex differences were observed between the groups at any point in entire study period. Third, due to the study's design, it was not possible to analyze the students' after-school activities and exercise habits throughout the study period. The sports club instructors might have inspired the children to join voluntary exercise activities after school or different activities during the spring, Easter, and winter holidays and also to join local sports clubs in the region. Fourth, the principal's concern regarding the level of physical activity of the children in the intervention school might have affected both students and teachers. However, this would most likely have been a result of the intervention and thus not have had direct or indirect impacts on the children's academic achievement. Moreover, there is evidence from several cohort and randomized trials that school-based interventions do not result in significant changes in physical activity level outside of school.[42,43]

Conclusion

Although not robust, these finding are in line with previous studies suggesting a link between physical activity and academic achievement. Promoting physical activity in school by means of a curriculum-based intervention program may improve children's educational outcome. However, the benefits of non-competitive physical activity and how this activity can be incorporated into school need to be further explored, and longitudinal controlled studies are warranted. Future research should also aim to provide better understandings of the mechanisms through which physical activity influences academic achievement both in the short- and long-term perspectives and the dose-response relationship between physical activity and academic achievement.

IMPLICATIONS FOR SCHOOL HEALTH

There has been a large shift toward less physically demanding work worldwide. The school environment is therefore one of the most important arenas for creating good life habits, initiate changes, and preventing good health by the promotion of physical activity. For some children, school may be the only place where they participate in any type of joyful physical activity, and our results support the view that the school system should provide opportunities and motivation for young people to be physically active.[5] The findings from our study indicate that a curriculum-based physical activity intervention is effective in improving academic achievement in children. Thus, the project strengthens the evidence that education can benefit from the neuroscientific insights into how children develop their learning. School physical education is declining in many countries due to schools focusing away from physical education and toward academics. The study however, suggests that cutting physical education classes to focus on academics might be counterproductive. The global decline in the number of hours dedicated to physical activity at schools should be taken into consideration because this decline appears to negatively affect children's capacity for learning. The present results, reinforcing previous studies linking physical activity and academic performance, have clear implications for policy makers. Schools should place more emphasis on physical education and physical activity programs not only to improve students' health but to raise their academic achievement as well. The cooperation between schools and local sports clubs might be a useful model that could be replicated in similar school environments to improve learning. The implementation of similar types of intervention should be encouraged. Physical education should thus be put in the spotlight and the Swedish government's commitment and agreement with the Swedish Sports Confederation appears to be successful way to impact on children's academic achievement.

Human Subjects Approval Statement

The Regional Ethical Review Board in Gothenburg (752-09) approved the study. Because the study is based on anonymous data sets where students' names were not recorded and thus the identity of the participants were not known to the researcher and cannot be disclosed, the Ethical Review Board declared the study to be exempt from the usual requirement of obtaining written informed consent.

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