The Relationship Between Physical Activity, Self-Esteem, and Academic Achievement in 12-Year-Old Children

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This study examined the relationships between children's reported levels of physical activity, body-mass index, self-esteem, and reading and mathematics scores, while controlling for sex, family structure, and socioeconomic status. The data were collected from the full population of Grade 6 students ($N = 6,923$) in New Brunswick (NB), Canada in 1996, as part of the Elementary School Climate Study, and the NB Department of Education's Grade 6 Assessment. Physical activity had a negative relationship with body-mass index. Physical activity had a positive relationship with self-esteem, and a trivial negative relationship with academic achievement. The analysis revealed that both females and males who were more physically active had considerably higher levels of self-esteem. The study suggests that the relationship between physical activity and academic achievement is weak. For some children, physical activity may be indirectly related to enhanced academic performance by improving physical health and self-esteem.

Participation in regular physical activity improves health. It strengthens cardiovascular function; reduces the risk of developing type II diabetes, hypertension, and hyperlipidemia; and positively influences choices pertaining to nutrition and the decision not to smoke (3). The evidence linking physical activity and health is stronger for adults than for children; however, the likelihood of being active as an adult is influenced by habits established during childhood (19, 25). An active lifestyle during childhood may also delay the onset of cardiovascular disease. Berenson et al. (2) found that fibrous plaque lesions develop during early childhood, and the extent of atherosclerotic development is related to blood pressure and body-mass index. Other research indicates that risk factors for cardiovascular disease, including obesity, hypertension, and elevated blood cholesterol levels, develop during childhood (13).

Despite the evidence linking physical activity during childhood to later health outcomes, physical education programs in elementary and secondary schools have slowly been eroded during the past two decades (24). Many educators and parents...
believe that spending time during school hours on physical activity inhibits children's chances of success in academic pursuits. Departments of education also maintain that the time and money spent on physical activity might be better spent on academic pursuits (14). These trends run contrary to research. A recent review by Shephard (20) concluded that academic learning per unit of class time is actually enhanced in physically active students. Indeed, most private schools subscribe to the belief that a sound body begets a sound mind (20).

Many researchers have reported the powerful relationship that participation in physical activity has with self-esteem (12). In most elementary settings, the development of self-esteem is a primary goal because it is considered to be an underlying factor determining student motivation, persistence, and academic success (30). Many children wish to be seen as competent in physical activity, especially within their own peer group (4, 22), and thus achievement in the physical domain may have a strong causal link to self-esteem (5). Indeed, Whitehead and Corbin concluded that physical activity can positively influence physical self-esteem and facilitate the most desirable forms of motivation (26). However, the research is unclear as to whether the relationship between physical activity and self-esteem is related to better academic results. Furthermore, the influence of socioeconomic status and body-mass index on the relationships among physical activity, self-esteem, and academic performance has not been well established.

Therefore, the purpose of this study was to examine the relationships between physical activity participation, self-esteem, body-mass index, and academic performance in a large sample of Grade 6 students in New Brunswick. The analysis controlled for socioeconomic status (SES), family structure, and gender. We believe this is the first study to describe these relationships for a large sample of Canadian children.

Methods

This study employed data from the Elementary School Climate Study (28). In the spring of 1996, a questionnaire was administered to the full population of Grade 6 students in New Brunswick. The data reported in this paper reflect only a portion of the information collected in the study, which was a multi-purpose study concerned with how various aspects of home and school environments affect children's attitudes, behaviors, and school achievement. The questionnaire asked students a number of questions pertaining to the academic and social climate of their classroom and school, their family background, their participation in physical activities, and several affective measures, including self-esteem. The questionnaire data were merged with students' test scores in reading, mathematics, science, and writing, which were based on standardized tests administered by the New Brunswick Department of Education. The total population of Grade 6 students in the province was 6,923. Of these, 6,856 students (99%) completed the achievement tests, and 5,146 students (74.3%) completed the questionnaires. Most cases of missing questionnaire data were due to schools not participating in the study. The test scores of those who completed the questionnaires were slightly lower (about 6% of a standard deviation) than the scores of those who did not complete the questionnaire. Thus, we do not suspect that non-response bias will substantially influence our regression estimates.
The outcome measures used in this study included students’ mathematics and reading scores, their BMI (which was constructed from students’ responses to questions about their height and body mass), and a general measure of self-esteem, which was based on 16 items from the Self Description Questionnaire (18). The self-esteem measure had a reliability (Cronbach’s alpha) of 0.88. (In preliminary analyses we examined models that used various subtests of the esteem measure, such as self-esteem about body image, peer relations, and academic achievement, but the results did not differ substantially from those based on the full scale.) Outcome measures for self-esteem, math score, and reading score were standardized to have a mean of zero and a standard deviation of one for the full population of New Brunswick Grade 6 students. SES values were also standardized in this fashion. Analysis results for all other variables are expressed relative to their traditional units.

The measure of physical activity was based on four questions regarding students’ regular participation in physical activities, both at school and outside of school. It asked students: “On how many days in the past week did you do the following: (a) exercise in sports that made you breathe hard, such as basketball, jogging, swimming, or fast cycling; (b) walk or bicycle for at least 20 minutes at a time; (c) do stretching exercises, such as toe touching, knee bending, or leg stretching; and (d) exercises to strengthen or tone your muscles, such as push-ups, sit-ups, or weight-lifting.” The question also included an item (e), “attend a phys. ed. class in school,” but we excluded it from the scale because its item-total score correlation was only .10, and its inclusion lowered the overall reliability of the scale. The sum of the results for the four questions was divided by four to obtain a single aggregate score for each student. The 4-item scale had a reliability of 0.68, and thus, some of our estimates of the effects associated with physical activity may be slightly underestimated. The primary covariate, SES, is a statistical composite derived from two sets of questions pertaining to students’ possessions in the home, and their family’s participation in cultural activities. Two measures of family structure, number of siblings and number of parents, were also used as control measures. Sex (labeled female) was coded 0 for males and 1 for females. Table 1 provides the means, standard deviations, and correlations among the principal measures, estimated separately for females and males. The analyses included several multiple regressions: (a) physical activity on the four covariates (female, SES, number of siblings, and number of parents); (b) self-esteem on the four covariates, with and without physical activity in the model; and (c) mathematics, reading, and BMI on the four covariates and physical activity, with and without self-esteem in the model. Finally, BMI was dichotomized (high BMI >95th percentile and low BMI <95th percentile; ref. 1), and a series of logistic regression models were fitted to the data. To further examine the relationship between physical activity and self-esteem, self-esteem scores from responses to the first activity question only—On how many days in the past week did you exercise in sports that made you breathe hard, such as basketball, jogging, swimming, or fast cycling?—were calculated for males and females.

Results

The regression coefficients for physical activity, presented in the first column of Table 2, indicate that SES was a significant predictor of physical activity levels (p
Table 1  Means, Standard Deviations, and Pearson Product-Moment Correlation Matrix of Variables Describing Examination Results, Physical Activity Level, Self-Esteem, Body Mass Index, and Socioeconomic Status for Males (Above Diagonal) and for Females (Below Diagonal)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Activity</th>
<th>BMI</th>
<th>Self-esteem</th>
<th>Math</th>
<th>Reading</th>
<th>SES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td></td>
<td></td>
<td>3.00</td>
<td>19.16</td>
<td>-0.02</td>
<td>0.02</td>
<td>-0.09</td>
<td>-0.06</td>
</tr>
<tr>
<td>SD</td>
<td>1.50</td>
<td>3.25</td>
<td>1.01</td>
<td>1.04</td>
<td>1.04</td>
<td>1.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activity</td>
<td>2.51</td>
<td>1.42</td>
<td>-0.073</td>
<td>5.08</td>
<td>-0.006</td>
<td>-1.15</td>
<td>-0.018</td>
<td>0.20</td>
</tr>
<tr>
<td>BMI</td>
<td>18.47</td>
<td>2.92</td>
<td>1.50</td>
<td>1.05</td>
<td>-0.005</td>
<td>-0.06</td>
<td>0.31</td>
<td></td>
</tr>
<tr>
<td>Self-esteem</td>
<td>-0.03</td>
<td>0.97</td>
<td>1.96</td>
<td>-0.09</td>
<td>-0.229</td>
<td>0.230</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math</td>
<td>-0.02</td>
<td>0.96</td>
<td>0.18</td>
<td>0.036</td>
<td>0.224</td>
<td>0.575</td>
<td>0.21</td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td>0.13</td>
<td>1.00</td>
<td>0.014</td>
<td>0.022</td>
<td>0.216</td>
<td>0.624</td>
<td>0.17</td>
<td></td>
</tr>
<tr>
<td>SES</td>
<td>0.07</td>
<td>0.98</td>
<td>0.20</td>
<td>-0.80</td>
<td>0.295</td>
<td>0.179</td>
<td>0.213</td>
<td></td>
</tr>
</tbody>
</table>

For each one standard deviation increase in SES, students' physical activity levels increased 0.4 units on the activity scale. Students in two-parent families, or in smaller families, were less likely to be physically active ($p < .001$). This is inconsistent with the pattern usually observed for the effects of family structure on schooling outcomes. Typically, children in two-parent families attain equal or superior academic achievement to children in single-parent families, and children in larger families tend to have slightly lower achievement scores (27). Females reported significantly lower levels of physical activity than males ($p < .001$).

The first regression model for self-esteem included only the four principal covariates. The results indicated that SES was positively associated with self-esteem, and that females had lower self-esteem than males. Children in two-parent families and children in smaller families had lower levels of self-esteem. In the second model (column 3 of Table 2), physical activity level was added to the model. Physical activity levels were significantly related to self-esteem ($p < .001$). Moreover, the significant difference between males and females in their levels of self-esteem disappeared after including physical activity levels in the model. Physical activity also had a mediating effect on SES, reducing its effect size from 0.357 to 0.320. These results suggest that females who are physically active are less likely to experience low levels of self-esteem, which is often the case for females during early adolescence.

The results for mathematics and reading indicate that SES is a relatively strong predictor of academic achievement; the effect sizes were about 20% of a standard deviation for a one standard deviation increase in SES. Females scored slightly lower, on average, than males on the mathematics test, but considerably higher than males on the reading test. Physical activity levels were negatively related to achievement, but the effect sizes were trivial: A one unit increase on the activity scale was associated with a reduction in test scores of 2–3% of a standard deviation. Self-esteem was positively related to achievement, with effect sizes of
Table 2  Regression Analysis Summary (Each Column Represents One Regression Equation and Each Row, the Calculated Unstandardized Beta for That Variable)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Activity</th>
<th>Self-esteem</th>
<th>Math score</th>
<th>Reading score</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>I</td>
<td>II</td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>SES</td>
<td>.403***</td>
<td>.357***</td>
<td>.320***</td>
<td>.182***</td>
<td>.116***</td>
</tr>
<tr>
<td>Female</td>
<td>-.554***</td>
<td>-.073**</td>
<td>-.022</td>
<td>-.078**</td>
<td>-.073**</td>
</tr>
<tr>
<td>Number of parents</td>
<td>-.494***</td>
<td>-.290***</td>
<td>-.245***</td>
<td>-.027</td>
<td>0.023</td>
</tr>
<tr>
<td>Number of siblings</td>
<td>.100***</td>
<td>0.30**</td>
<td>.021*</td>
<td>-.005</td>
<td>-.009</td>
</tr>
<tr>
<td>Activity</td>
<td>—</td>
<td>—</td>
<td>.091***</td>
<td>-.022*</td>
<td>-.040***</td>
</tr>
<tr>
<td>Self-esteem</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>.205***</td>
</tr>
</tbody>
</table>

***Regression is significant at the .001 level (2-tailed).
**Regression is significant at the .01 level (2-tailed).
*Regression is significant at the .05 level (2-tailed).
Figure 1 — The relationship between self-esteem and vigorous physical activity for females and males. Bar widths represent relative distribution of each response.

about 20% of a standard deviation. To place these effect sizes in perspective, an effect size for test scores of 10% of a standard deviation, at this grade level, is roughly equivalent to about 1 to 1.5 months of academic instruction (29). Thus, the negative effect associated with a dramatic increase in physical activity amounts to about 1 to 2 weeks of additional academic instruction.

Figure 1 illustrates the strong positive relationship between the frequency of participation in vigorous physical activity and self-esteem. The trend is similar for both females and males.

SES was negatively associated with BMI; a one standard deviation increase in SES was associated with a reduction in BMI of 0.296. Female BMIs were on average about one point lower than male BMIs. BMI was not significantly related to family structure. In the first model, which did not include self-esteem, increased physical activity was associated with a decrease in BMI of 0.090. In the last model, self-esteem was included with physical activity levels and the other covariates. Students with higher self-esteem, on average had lower BMIs. The significant effect of increased physical activity was lost with the inclusion of self-esteem in the model. Although the effect of increased physical activity on BMI is fairly small, it is important to note that this is the effect on BMI over and above the effects associated with SES. On a population basis, even a small reduction in BMI can have positive and significant long-term implications for children’s health and well-being (1).

Table 3 presents the odds ratios of having an excessively high BMI (a BMI above the 95th percentile). The first model indicates that students who had a high SES were 80% as likely (or 20% less likely) to have a high BMI as a child with average SES. Females were about half as likely as males to have a high BMI.
Table 3  Odds Ratio Analysis of Having a High BMI (>95th Percentile) (Calculated Beta for Each Variable in the Regression Equation)

<table>
<thead>
<tr>
<th>Variable</th>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>SES</td>
<td>.8037**</td>
<td>.8405*</td>
<td>.9125</td>
</tr>
<tr>
<td>Female</td>
<td>.5423***</td>
<td>.5079***</td>
<td>.5050***</td>
</tr>
<tr>
<td>Number of parents</td>
<td>1.3738</td>
<td>1.3052</td>
<td>1.2194</td>
</tr>
<tr>
<td>Number of siblings</td>
<td>.9450</td>
<td>.9554</td>
<td>.9596</td>
</tr>
<tr>
<td>Activity</td>
<td>—</td>
<td>.8865*</td>
<td>.9071*</td>
</tr>
<tr>
<td>Self-esteem</td>
<td>—</td>
<td>—</td>
<td>.7800**</td>
</tr>
</tbody>
</table>

***Regression is significant at the .001 level (2-tailed).
**Regression is significant at the .01 level (2-tailed).
*Regression is significant at the .05 level (2-tailed).

Increased levels of physical activity were associated with about a 10% reduction in the likelihood of having a high BMI. Students with high self-esteem were 78% as likely to have a high BMI.

Discussion

This study examined the relationships between increased physical activity, students’ self-esteem, academic achievement, and BMI, for the full population of Grade 6 students in New Brunswick. The analysis examined differences between males and females, and included controls for family structure and SES. Four important findings emerged from the analysis. First, physical activity levels were significantly related to self-esteem, even after taking account of SES. Second, an increase in vigorous physical activity levels was associated with progressive improvements in self-esteem in both females and males. Third, increased levels of physical activity had a very weak relationship with academic achievement in both mathematics and reading. Fourth, increased levels of physical activity were associated with a slightly lower BMI, and approximately a 10% reduction in the likelihood of having an excessively high BMI.

New Brunswick is a small province in Atlantic Canada with levels of family income that are well below the national average. Recent data from the Canadian Fitness and Lifestyle Research Institute suggest that people in Atlantic Canada are less active than those living elsewhere in Canada (7). Furthermore, Tremblay et al. (24) have reported that the quantity and quality of physical education programs in New Brunswick are being eroded, especially at the elementary level. Schools in New Brunswick, and elsewhere, are under increased pressure to have students perform well on provincial academic exams. Ironically, based on the findings from this study, efforts to increase physical activity and physical education time may indirectly help achieve this goal by enhancing self-esteem.
Cross-sectional studies of the relationship between physical activity and academic performance have generally revealed a positive relationship between fitness scores, or participation in athletic programs, and academic success, as gauged by grade point averages, report card results, and IQ scores (10, 17, 20, 23). These relationships may be spurious, however. Success in both athletic and academic pursuits are arguably influenced by genetic endowment and early developmental experiences, which are encouraged and maintained by supportive parents. This research has been further criticized because fitness scores and participation in athletics are poor indicators of regular physical activity (17), and grades derived from teacher assessments tend to reflect a child’s standing in a class rather than gains in learning. Perhaps more important, though, these studies failed to control adequately for students’ family background or their academic status prior to receiving the intervention.

Shephard (20) discussed the findings of longitudinal studies conducted in France, Australia, and Canada. The French research (11, 15), conducted in a suburb of Paris in 1950, is widely cited because it entailed a dramatic intervention: Students in the experimental school received vitamin supplements and participated every afternoon in a wide range of physical activities. Their siesta periods were also increased. Even though the school day was lengthened to accommodate some of the additional time spent on physical activity and siestas, time devoted to academic instruction was reduced by 26%. The study found that children in the experimental school were equally likely to receive a “certificate of study” as control students attending schools elsewhere in Paris, and that the teachers in the experimental school reported that their students appeared more calm and attentive during academic instruction, presented fewer disciplinary problems, and had better attendance. Although the study lacked the scientific rigor of a controlled experiment by today’s standards, and entailed more than one intervention, it suggests that enhanced physical activity at the expense of instructional time does not necessarily lead to poorer academic performance.

Research conducted in Australia also supports the notion that increased curricular time spent on physical education, particularly fitness oriented activity, facilitates academic progress despite a reduction in academic instruction time (8, 9). In the School Health, Academic Performance and Exercise (SHAPE) study, Dwyer and colleagues (9) examined the effects of increased physical education (PE) on children’s (Grade 5) academic development. They studied three groups: control (3 x 30-min classes of PE per week), fitness (75 min of PE per day with a focus on cardiovascular fitness), and skill (75 min of PE per day with a focus on skill development). Despite a significant curtailment of scheduled academic learning time, there were no significant differences between groups on gains in arithmetic or reading skills. Indeed, there were significantly larger improvements in classroom behavior scores in the PE-enhanced groups and a trend towards improved arithmetic scores in the fitness group compared to the others. Follow-up research by the investigators suggested that the students exposed to the PE intervention developed an advantage over the control students for arithmetic and reading scores 2 years after the intervention while maintaining better classroom behavior scores (8).

The Trois Rivières study conducted by Shephard et al. (21) had 546 primary school students representing the experimental group, while those children in the immediately preceding and succeeding classes acted as controls. The
The experimental group had 1 extra hour per day of physical activity supplied by a specialist and a 14% reduction in academic time, yet all children were exposed to a similar overall academic environment. The results of the 6-year longitudinal study demonstrated that, although the control groups had better initial academic grades, the experimental group outperformed the controls significantly in Grades 2, 3, 5, and 6. A conclusion drawn by the authors was that classroom assessment was improved rather than worsened when some school time was spent in required programs of physical activity.

The cross-sectional design of the present study clearly limits the conclusions that can be drawn, and one cannot attribute causation to any of the observed relationships. For example, we cannot infer that an increase in physical activity, as part of a school program, would necessarily improve children’s self-esteem. The observed relationship between physical activity and esteem may be attributable to children with higher levels of self-esteem having the confidence necessary to participate in physical activities. However, given the strength of the observed relationship, it is unlikely that increases in physical activity would have a deleterious effect on self-esteem. Indeed, the French (15), Australian (8, 9) and Quebec (21) studies all noted that teachers felt children were better behaved and more motivated in their studies as a result of increased physical activity.

Self-esteem tends to decline for many youth, particularly females, during adolescence. The findings of this study suggest that participation in physical activities, and especially vigorous physical activities, may help some youth traverse this difficult period. Alternatively, it may be that many youth face barriers to participation, and that it is mainly those with strong self-esteesms that participate. Either way, the results call for measures that would increase access to physical activities for all adolescents, and especially females.

The finding that higher levels of physical activity had relatively small effects on academic achievement is consistent with the findings of previous cross-sectional and longitudinal studies (20). However, our measure of physical activity provides only a rudimentary account of the quality and quantity of students’ physical activity. In a study of this kind, it is not possible to measure students’ heart rates, or to obtain a detailed account of their week’s physical activity. Also, we do not have a measure of how much academic time, either inside or outside of the classroom, was lost due to increased physical activity. It may be, for example, that increased physical activity is associated with an improvement in academic achievement, up to some optimal level, but that too much time on physical activity detracts from academic pursuits. We require longitudinal intervention studies, with accurate measures of the quantity and quality of physical activity, to discern the appropriate levels of physical activity for children at various ages. Nevertheless, the significant positive relationship between physical activity and self-esteem demonstrated in this study, after controlling for SES and family structure, provides a potential explanation for the improved academic performance observed with significant increases in physical activity in other studies (8, 9, 15, 21).

The relationship between physical activity and BMI is to be expected, and the result to some extent validates our measure of physical activity. The findings from this study indicate that students with high BMI values have lower self-esteem, which supports previous research from Corbin et al. (6) that demonstrated
lower self-esteem profiles in children above the national criteria for body fatness. Table 3 indicates that an increase of one unit on the physical activity scale is associated with a 10% reduction in likelihood of having a high BMI (>95th percentile). Table 3 also shows that higher levels of self-esteem are associated with a significant reduction in risk of having a high BMI. Clearly, these results support efforts to promote physical activity among children and youth, not only to reduce the risk of having a high BMI, but also to receive the rewards associated with enhanced self-esteem.

In summary, this study demonstrated that physical activity had a negative relationship with BMI, a positive relationship with self-esteem, and a trivial negative relationship with academic achievement. The analysis revealed that both males and females who were more physically active had considerably higher levels of self-esteem. The study suggests that the relationship between physical activity and academic achievement is weak. For some children, physical activity may be indirectly related to enhanced academic performance by improving physical health and self-esteem.

References


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