Adolescent Physical Activities as Predictors of Young Adult Weight

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Objective: To examine the relationship between increased physical activity in adolescence and adult weight status.

Design: Cohort study based on data from the National Longitudinal Study of Adolescent Health.

Setting: In-home interviews.

Participants: A total of 3345 adolescents in grades 8 to 12 with body mass index (calculated as weight in kilograms divided by height in meters squared) data available at baseline and 5 years later.

Main Exposures: Days per week of curricular and extracurricular physical activity.

Main Outcome Measure: Overweight status (body mass index ≥25) 5 years after baseline.

Results: Increasing participation in certain extracurricular physical activities and physical education decreased the likelihood of young adulthood overweight. Regarding extracurricular physical activities, the likelihood of being an overweight adult was reduced most (ie, 48%) by performing certain wheel-related activities (ie, rollerblading, roller skating, skateboarding, or bicycling) more than 4 times per week. Each weekday that adolescents participated in physical education decreased the odds of being an overweight adult by 5%, with participation in all 5 weekdays of physical education decreasing the odds by 28%. In general, physical activity predicted normal-weight maintenance better than weight loss.

Conclusion: These data underscore the important role that school-based and extracurricular physical activity play in reducing the likelihood of transitioning to overweight as young adults.


Sixteen percent of US adolescents are currently overweight or obese,¹ and 85% of obese adolescents become obese adults.² The prevalence of overweight in adolescents has more than tripled since 1980.¹,³ In the pediatric population, adolescent overweight is the best predictor of adulthood overweight; however, to date, no single intervention in adolescence has proved to be effective in reducing the transition to adult overweight.⁴,⁵ The aim of this study was to examine the relationship between increased physical activity in adolescence and adult overweight because adolescent exercise may prove to be an effective strategy for combating the adulthood obesity epidemic.

It is generally accepted that increased physical activity, independent of weight status, has many healthful effects throughout the lifespan, including increased bone mineral density, improved lipid profile, increased cardiovascular endurance, improved glucose metabolism, increased muscle strength, and lower blood pressure.⁶,⁷ In adolescents, increased physical activity has been linked to lower tobacco and marijuana use, less television watching, higher fruit and vegetable consumption, less depression, closer relationships with parents, and decreased social marginalization.⁸,⁹ In addition, cross-sectional data from the Third National Health and Nutrition Examination Survey¹¹ and the 1999 Youth Risk Behavior Survey¹² have established an association between increased physical activity in adolescence and lower weight in certain subgroups.

Daily physical education (PE) is recommended across all grade levels by a variety of organizations, including the Institute of Medicine,¹³ the US Department of Health and Human Services,¹⁴ and the American Academy of Pediatrics.¹⁵ However, 44.3% of high school students are not enrolled in any PE, and PE participation declines with each increasing high school grade level.¹⁶ Although most school districts have some PE requirement for their high schools,¹⁶ on the individual high school level only 13.3% of freshmen and 5.4% of seniors are required to take PE.⁹ Furthermore, only 6.4% of middle and junior high schools and 5.8% of senior high schools have daily physical education.¹⁶

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schools provide daily PE. In addition, evidence indicates that even when students participate in PE, they are vigorously active for less than 10% of the allotted time.

Only a few longitudinal studies have addressed the relationship between physical activity and weight in the pediatric population. A 2-year study of kindergarteners demonstrated that 1 additional hour per week of PE predicted decreased body mass index (BMI) (calculated as weight in kilograms divided by height in meters squared) in overweight or at-risk-for-overweight girls. An 8-year study of 4- to 11-year-olds revealed that increased physical activity reduced weight in boys and girls. A 1-year study of adolescents indicated that the likelihood of being overweight decreased with high levels of moderate to vigorous physical activity for Hispanic and African American boys and girls and for white boys. Finally, a recent 9-year study of girls aged 9 to 19 years demonstrated that extracurricular physical activity was inversely correlated with adiposity and BMI, independent of caloric intake.

This article reports the first longitudinal study describing the relationships between school-based and extracurricular physical activities in adolescence and adult hood weight status 5 years later. The study tests the hypothesis that adolescents who participate in more exercise are less likely to transition to overweight as adults.

METHODS

The present analyses were based on data from the National Longitudinal Study of Adolescent Health (Add Health), a longitudinal survey of adolescents in the United States, collected under protocols approved by the institutional review board of the University of North Carolina at Chapel Hill. The intent of the original Add Health was to establish a public use database on a nationally representative sample of youth in grades 7 through 12 with a focus on a range of behaviors associated with positive and negative health and social outcomes. The sample was drawn initially from a school-based sample starting with 80 high schools. A high school was defined as having an 11th grade and at least 30 students (range, approximately 40 to >5400 students). Subsequently, the primary feeder school to the identified high school was selected, yielding a sample of 134 schools. A school-based survey was undertaken in 129 of the identified schools involving more than 90,000 students; from those participants and from the rosters of students in the nonsurveyed schools, a sample of 15,243 students in grades 7 through 12 were invited to participate in the in-home wave 1 survey. Of those students, 12,105 (79.4%) agreed to participate. Wave 2 data, used for the present analysis, were collected, on average, a year after wave 1 on all identified wave 1 participants who, at that time, were in grades 8 to 12. The present analyses were approved by the Committee on Human Research, Johns Hopkins Bloomberg School of Public Health. Waves 2 and 3 were used, providing longitudinal data approximately 5 years apart (noted in these analyses as times 0 and 1), enabling us to study transitions into young adulthood. Wave 2 was selected because it contained the school-based and extracurricular physical activity questions used in the present analysis. Wave 3 included 4882 of the original respondents, who were then 18 through 26 years of age. Participants included 3345 adolescents who in 1996 were in 8th through 12th grades and reported their school-based and extracurricular physical activities. Self-reported anthropometric data were collected from these participants 5 years later, in 2001 and 2002.

To ensure a consistent definition of overweight between waves, we used the International Obesity Task Force criteria to yield time 0 BMIs with numerical rather than percentile-based weight status cutoff values that are consistent between adolescent and adult standards. The rationale for using the International Obesity Task Force criteria rather than the more conventional Centers for Disease Control and Prevention pediatric growth curve was that if the latter were used, an individual who was not overweight (as measured by BMI <95th percentile) might be considered overweight at the 21st birthday without having gained any weight owing to having a BMI of 25 or greater. For the purposes of the present study, overweight was defined as a BMI of 25 or greater and normal weight as below that cutoff point, allowing for more consistent cross-age comparisons.

Exclusionary criteria for either period were pregnancy, physical disability, weight greater than 400 kg, age outside the study range, and insufficient data available to calculate BMI. Time 0 predictors were the number of times in the past week respondents participated in PE and in 3 categories of physical activity, defined by Add Health as follows: type 1: rollerblading, roller skating, skateboarding, and bicycling; type 2: baseball, softball, basketball, soccer, swimming, and football; and type 3: jogging, walking, karate, jumping rope, gymnastics, and dancing. Any individual could participate in none, some, or all of these activity types; however, selection options required respondents to indicate activity by exercise type rather than by specifying the activity in which they participated. Respondents were not asked about duration, location, or intensity of physical activity.

Sex was dichotomized. Respondents selected 1 or multiple racial/ethnic categories; when multiple races were selected, respondents were then asked to select the one with which they most identified. Age was calculated based on date of birth.

Multiple logistic regression analyses were used adjusting for sex, race/ethnicity, and age because previous research indicates that adolescent physical inactivity is greater in females, certain ethnic minorities, and older individuals. We used interaction expansion to analyze statistical significance within and between categorical variables. This technique expands terms containing categorical variables into dummy variables by creating a new set of variables. Statistical significance was set at P<.05. Unless otherwise specified, all statistically significant results are reported at P<.05. We did not include socioeconomic status indicators in the multivariate model because previous research indicates that such factors have only a limited effect on adolescent weight disparities. Statistical analyses were performed using the special edition version of STATA 8.0 (Stata Corp., College Station, Texas).

RESULTS

The study population’s distribution of sex, age, and race/ethnicity as well as the frequency of participation in the various physical activities are described in Table 1. Reported rates of adolescent participation in activity types 1, 2, and 3 for the week before the survey were 37.1%, 73.0%, and 85.6%, respectively. A bimodal distribution was found for PE participation in the week before time 0, with 44.4% of respondents reporting no days of PE and 35.9% reporting daily PE.

Prevalence of overweight at time 0 and time 1 is given in Table 2. During the 5-year period, the prevalence of overweight nearly doubled (from 28.1% to 50.6%), resulting in more than half of the adolescents in the sample being overweight as young adults. Of 941 overweight adolescents, only 103 (10.9%) transitioned to normal weight as young adults.
The odds of becoming overweight according to school-based physical activity were analyzed using the aggregate study population and stratifying by weight status at time 0 (Table 3). In the aggregate population, each weekday that adolescents participated in PE decreased the odds of being an overweight adult by 5%. Furthermore, adolescents who participated in all 5 days of PE were 28% more likely to be normal-weight adults than their peers who did not.

Consistent with the aggregate data, normal-weight adolescents who participated in PE were 5% less likely to be overweight for every day of PE. Normal-weight adolescents who participated in all 5 days of PE were 33% more likely to be normal-weight adults. However, for overweight adolescents, PE did not have the same salutary effect.

The results of the present analyses provide evidence that school-based and extracurricular physical activities during adolescence, when engaged in more than twice per week, may contribute to the prevention of adulthood overweight. Except for type 3 activities (jogging, walking, karate, jumping rope, gymnastics, and dancing), participation in other physical activities at certain frequencies (>4 times per week for type 1 and 3 to 4 times per week for type 2 activities) improved the odds of becoming or remaining a normal-weight adult. Overall, the apparent protective effect of physical activity on adult weight status is more prominent in adolescents who started out with a normal weight, suggesting that physical activity may be a more effective strategy for normal-weight maintenance than for excess-weight loss. Accordingly, a greater emphasis on prevention, rather than intervention, may be well warranted in approaching the obesity epidemic.

It is somewhat surprising that type 3 activities did not predict adulthood weight status because activities such as jogging, walking, karate, jumping rope, gymnastics, and dancing, are perceived as particularly beneficial for weight management.

In contrast, of 2404 normal-weight adolescents, 855 (35.6%) transitioned to overweight as young adults.

The odds of becoming overweight based on extracurricular physical activities were analyzed using the entire study population and weight strata subgroups at time 0 (Table 4). No association between physical activity and weight status was seen in any of the 3 categories of exercise when performed fewer than 3 times per week. Of activities engaged in 3 or more times per week, only type 1 and 2 activities predicted decreased odds of being overweight in early adulthood. For the entire study population, the likelihood of being an overweight adult was reduced 48% by performing type 1 activities more than 4 times per week (P=.03) and 20% by performing type 2 activities 3 to 4 times per week (P=.04). A protective association was not seen for type 2 activities performed more than 4 times per week.

Stratification by time 0 weight status showed that normal-weight adolescents who participated in type 1 activities more than 4 times per week were more than twice as likely (odds ratio, 2.04) to remain normal-weight adults compared with normal-weight adolescents not participating in similar activities. A trend suggested that overweight adolescents who participated in type 1 activities 3 to 4 times per week were 85% more likely to become normal-weight adults than overweight adolescents not participating in type 1 activities (P=.08). No consistent trends or significant results were found for type 2 or 3 activities when stratifying by time 0 weight status.

The days in the past week participating in any activity in the following categories, defined by the National Longitudinal Study of Adolescent Health: type 1: rollerblading, roller skating, skateboarding, or bicycling; type 2: baseball, softball, basketball, soccer, swimming, or football; and type 3: jogging, walking, karate, jumping rope, gymnastics, or dancing.

Physical education participation data were available from only 2102 participants.

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as jumping rope and dancing can be high intensity. This outcome might reflect that adolescents performing type 3 activities may, on average, do fewer other activities, whereas those involved in type 1 and 2 activities might do some type 3 activities as well but may view them (eg, jogging and jumping rope) as preparatory for their primary forms of exercise. In addition, those engaged in more diverse exercise regimens as adolescents may view other type 3 activities (eg, dancing) less as exercise and more as a social event. Alternatively, type 3 activities may disproportionately select for individuals with increased muscle mass (perhaps leading to increased overweight misclassifications). The analyses are limited by our inability to disaggregate individual physical activities.

This study has several limitations. Because adolescents, particularly boys, who are underweight or at risk for underweight may be less likely to be physically active than normal-weight students, the protective effects of exercise on normal- and high-normal-weight individuals may be offset by these lower-weight nonexercisers. Second, as noted earlier, exercise categories were grouped by response category rather than by discrete activities, activities more likely to persist across time, or activities associated with similar caloric expenditures. Third, we cannot ascertain whether patterns for the 3 physical activity types were engaged in on an ongoing basis because exercise participation was measured only at 1 week in time. Finally, as suggested previously, overweight misclassifications may occasionally occur (eg, from increased muscle mass) owing to BMI not optimally reflecting adiposity; however, research indicates that adolescent BMI successfully predicts adulthood total body fat and percentage of body fat.

In conclusion, establishing a temporal and positive relationship between adolescent physical activity and lower adult weight status is especially important given current trends in adolescent exercise patterns.”

### Table 3. Adolescent Extracurricular Physical Activity and the Odds of Being Overweight as Adults

<table>
<thead>
<tr>
<th>Time 0 Activities, d/wk</th>
<th>Being (Becoming or Remaining) Overweight at Time 1 (Total Sample)</th>
<th>Becoming Overweight at Time 1 (Normal Weight at Time 0)</th>
<th>Remaining Overweight at Time 1 (Overweight at Time 0)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Odds Ratio (95% Confidence Interval)b</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Type 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1 [Reference]</td>
<td>1 [Reference]</td>
<td>1 [Reference]</td>
</tr>
<tr>
<td>1-2</td>
<td>0.96 (0.81-1.14)</td>
<td>1.00 (0.81-1.23)</td>
<td>1.20 (0.69-2.09)</td>
</tr>
<tr>
<td>3-4</td>
<td>0.82 (0.63-1.06)</td>
<td>0.93 (0.68-1.28)</td>
<td>0.54 (0.28-1.06)</td>
</tr>
<tr>
<td>&gt;4</td>
<td>0.52 (0.38-0.71)c</td>
<td>0.49 (0.32-0.73)c</td>
<td>0.90 (0.35-2.31)</td>
</tr>
<tr>
<td><strong>Type 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1 [Reference]</td>
<td>1 [Reference]</td>
<td>1 [Reference]</td>
</tr>
<tr>
<td>1-2</td>
<td>0.95 (0.79-1.14)</td>
<td>1.03 (0.82-1.30)</td>
<td>0.86 (0.47-1.58)</td>
</tr>
<tr>
<td>3-4</td>
<td>0.80 (0.65-0.99)c</td>
<td>0.85 (0.65-1.11)</td>
<td>0.64 (0.34-1.20)</td>
</tr>
<tr>
<td>&gt;4</td>
<td>0.91 (0.74-1.11)</td>
<td>1.03 (0.81-1.32)</td>
<td>0.97 (0.49-1.89)</td>
</tr>
<tr>
<td><strong>Type 3</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1 [Reference]</td>
<td>1 [Reference]</td>
<td>1 [Reference]</td>
</tr>
<tr>
<td>1-2</td>
<td>1.05 (0.84-1.30)</td>
<td>1.05 (0.80-1.38)</td>
<td>0.92 (0.47-1.82)</td>
</tr>
<tr>
<td>3-4</td>
<td>1.00 (0.80-1.25)</td>
<td>1.10 (0.83-1.46)</td>
<td>0.63 (0.32-1.24)</td>
</tr>
<tr>
<td>&gt;4</td>
<td>1.15 (0.92-1.45)</td>
<td>1.21 (0.91-1.59)</td>
<td>1.19 (0.58-2.45)</td>
</tr>
</tbody>
</table>

a See footnote b in Table 1.
b Adjusted for age, sex, and race/ethnicity.
c *P* < .05.

### Table 4. Adolescent Curricular Physical Activity and the Odds of Being Overweight as Adults

<table>
<thead>
<tr>
<th>PE Attendance at Time 0, d/wk</th>
<th>Being (Becoming or Remaining) Overweight at Time 1 (Total Sample)</th>
<th>Becoming Overweight at Time 1 (Normal Weight at Time 0)</th>
<th>Remaining Overweight at Time 1 (Overweight at Time 0)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Odds Ratio (95% Confidence Interval)b</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1 [Reference]</td>
<td>1 [Reference]</td>
<td>1 [Reference]</td>
</tr>
<tr>
<td>1-4</td>
<td>0.97 (0.76-1.23)</td>
<td>0.89 (0.66-1.21)</td>
<td>1.47 (0.69-3.13)</td>
</tr>
<tr>
<td>5</td>
<td>0.78 (0.64-0.96)c</td>
<td>0.75 (0.58-0.97)c</td>
<td>1.33 (0.70-2.55)</td>
</tr>
<tr>
<td>Each additional day</td>
<td>0.95 (0.92-0.99)c</td>
<td>0.95 (0.90-1.00)c</td>
<td>1.07 (0.94-1.22)</td>
</tr>
</tbody>
</table>

Abbreviation: PE, physical education.
a Days in the past week participating in PE; the last row designates outcome on a continuous scale.
b Adjusted for age, sex, and race/ethnicity.
c *P* < .05.
research indicates that most adolescents do not participate in moderate physical activity 5 or more times per week, and these patterns persist into adulthood.

In the current climate of decreasing adolescent physical activity in and out of school, it is important for policy makers to have firm evidence that justifies increasing time and bolstering resources for quality exercise programs and sports. In view of an obesity epidemic costing the United States an estimated $117 billion annually, policy makers now have evidence that a relatively low-cost strategy may offer a long-lasting solution.

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