Published in final edited form as:

J Adolesc Health. 2007 May ; 40(5): 462.e1–462.e8.

Adolescent physical activity and perceived competence: does change in activity level impact self-perception?

Cynthia J. Stein, MD, MPH,

Instructor of Medicine, Channing Laboratory, Department of Medicine, Brigham and Women's Hospital and Harvard Medical School

Laurie Fisher, SM,

Research Associate, Channing Laboratory, Department of Medicine, Brigham and Women's Hospital and Harvard Medical School

Catherine Berkey, ScD, and

Lecturer in Medicine, Harvard Medical School and Brigham and Women's Hospital

Graham A. Colditz, MD, DrPH

Professor of Medicine, Channing Laboratory, Department of Medicine, Brigham and Women's Hospital and Harvard Medical School

Abstract

Purpose—To determine whether change in physical activity level impacts adolescents' self-perceptions.

Methods—Using questionnaire responses from the Growing Up Today Study (GUTS) in 1997 and 1999, we evaluated data from 5,260 girls and 3,410 boys. Physical activity changes were compared to changes in perceived competence in 3 domains (social, athletic, and scholastic) as well as in global self-worth. Analyses controlled for sibling clustering as well as for potential confounders, including body mass index, cigarette smoking, baseline activity levels, and baseline self-perception scores.

Results—For girls and boys, increase in physical activity was positively associated with change in social and athletic ($p < 0.0001$), but not scholastic or global. self-perception. Compared to those with little or no change in activity, those who increased physical activity were more likely to have increased self-perception measures. Girls who increased physical activity by 5 or more hours/week were at least 33% more likely to have increased social self-perception, and at least 44% more likely to have increased athletic self-perception. In boys, those who increased activity by 10 or more hours/week were 45% more likely to have increased social self-perception. The reverse was also true; for both girls and boys, those with decreased physical activity were more likely to have decreased self-perception scores.

Conclusions—This research indicates that increased physical activity has a positive impact on athletic and social self-perception in girls and boys.

Correspondence and reprints: Cynthia J. Stein, Harvard Center for Cancer Prevention, 401 Park Drive, Landmark 3-E, Boston, MA 02215. email cynthia.stein@post.harvard.edu

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Introduction

Physical activity has many health benefits. In addition to decreasing the risk of obesity, cancer, cardiovascular disease, type 2 diabetes, and osteoporosis, physical activity also has positive effects on mental and emotional health. It reduces symptoms of anxiety and depression,[1] and is associated with an increase in self-confidence [2] and an improved sense of well-being.[3] Studies have suggested that exercise programs are associated with increased self-esteem scores, especially in individuals with low self-esteem at baseline. [3] Many hypotheses have been developed to explain the measured increase in self-esteem, including improved fitness, feeling of somatic well being, goal achievement, sense of competence, reinforcement from others, adoption of related health behaviors, and social interaction.[3]

While much of the research has been done with adults, a variety of studies have examined the effects of physical activity on psychosocial variables specifically in children and adolescents, with inconsistent results. Correlations between physical activity and self-efficacy,[4] self-confidence,[5] self-concept,[6] and self-esteem [4,7] have been reported in younger populations. In addition, adolescents who exercise infrequently have an increased risk of feelings of loneliness, shyness, and hopelessness,[8] and physical activity has been inversely associated with depression.[9] In a cross-sectional study of 92 children between the ages of 10 and 16, Strauss et al found that self-efficacy was associated with physical activity and concluded that high-level physical activity was important in the development of self-esteem in children.[4]

However, not all studies have shown a positive association between physical activity and self-esteem. In a review of the literature from 1970–1998, Sallis et al concluded that in adolescents self-efficacy and perceived competence had an indeterminate relationship with physical activity, and there was no association seen between physical activity and self-esteem.[9]

It is the goal of this study to use longitudinal data to further evaluate the relationship between physical activity and different facets of self-perception in adolescents, specifically in the areas of social, athletic, scholastic and global self-perception.

Methods

Materials and measures

Study Cohort—Growing Up Today Study (GUTS) participants were recruited by identifying women in the ongoing Nurses' Health Study II who had children between the ages of 9 and 14 in 1996. Letters were sent to 34,174 mothers explaining the design of the study, and 18,526 consented and provided information for 26,765 children. Each child was then sent an introductory letter with a gender-specific questionnaire. The prospective participants were assured confidentiality. The cohort is comprised of 16,882 children, 9,039 girls (54%) and 7,843 boys (46%), who responded to the baseline survey in 1996, thereby consenting to participate in the study. Follow-up self-report questionnaires are mailed to the participants. Further details of recruitment and establishment of the GUTS cohort are described elsewhere [10]. The study was approved by the Human Subjects Committees at the Harvard School of Public Health and Brigham and Women's Hospital.

From the cohort, 6240 girls and 4461 boys responded to both the 1997 and 1999 questionnaires, for an overall response rate of 63%. In the 1999 survey cycle, participants who did not respond to the initial mailing of the full questionnaire were sent a shortened version. Neither activity nor self-perception questions were included on this shortened version. Thus, 518 girls and 529 boys who returned the shortened 1999 questionnaire were excluded from these analyses. An additional 223 girls and 330 boys who did not respond to the physical activity questions in

both 1997 and 1999 or who reported unrealistic amounts of activity were excluded, as well as 53 girls and 67 boys who did not respond to any of the four domains of self-perception in both 1997 and 1999. Finally, 186 girls and 125 boys who did not provide data for the calculation of body mass index (BMI) or who had unrealistic BMI measures were excluded from the analyses. The final sample included 5,260 girls and 3,410 boys.

Physical activity—Participants answered questions about the number of hours/week (hrs/wk) they were involved in a variety of activities, such as swimming, martial arts, walking, running, strength training, and gymnastics, for each season during the previous year. The question excluded gym class. For each activity, there were 6 answer categories for hrs/wk (0, < ½, ½–3, 4–6, 7–9, ≥10). From the participant's responses, using one value for each answer category (0, 0.25, 1.75, 5, 8, 10 hrs/wk respectively), an average number of hrs/wk of activity was calculated. This total number of hrs/wk was used in the analyses. Values which represented an unrealistic total number of hours of activity per week (≥40) were excluded. Assessments of this instrument found that activity estimates were moderately reproducible and reasonably correlated with cardio-respiratory fitness, thus providing evidence of validity. [11] Another validation study reported a correlation of $r=0.80$ between survey self-reports and 24-hour recall in sixth- to eight-grade children. [12] The seasonal format used in this study was developed to further improve reliability and validity. [13]

Change in physical activity between 1997 and 1999 was examined both as a continuous variable and as a categorical variable with five categories of hrs/wk (increased by >10 hours, increased 5–10 hours, changed in either direction by less than five hours, decreased 5–10 hours, or decreased by >10 hours). Five-hour increments were chosen as they represent one additional hour of activity per day on 'most days' of the week.

Self-perception—We used a modified version of the Harter Self-Perception Profile for Children,[14] which is a tool for measuring children's self-perceptions of competence in separate domains and in global self-worth. The Harter scale presents 2 statements, and participants are first asked to choose which of the statements better describes them ("some kids often forget what they learn" but "other kids can remember things easily") and then to indicate the degree to which the selected statement applies to them ("really true for me" or "sort of true for me.").

In small group testing, 165 students in 4th–6th grade found the Harter scale questions difficult to complete despite oral and written instructions. Based on the surveys conducted and the results of the focus group testing, a modified Harter Scale was developed. This modified scale presents a series of statements, both positive ("some kids feel that they are very good at their school work") and negative ("some kids often forget what they learn"), and asks participants to indicate the degree to which each statement applies to them: "really true for me" "sort of true for me" or "not true for me."

This modified scale was used in the GUTS questionnaire. A series of 24 statements relating to four aspects of self-perception (scholastic skill, athletic ability, social acceptance and global self-worth.) were presented with six statements in each area. Participants were then asked whether each statement was "really true for me" "sort of true for me" or "not true for me." Each response was assigned a point value from 1 (lowest self-perception) to 3 (highest self-perception), so that scores ranged from 6 to 18 points for each area. The total score for each of the 4 areas was used in the analyses. In the case where a participant responded to only 5 of the 6 statements in a given area, the mean of the 5 responses (1–3 points) was used to estimate the child's missing response. Any area that did not contain at least 5 of 6 answers was excluded for that child.

Change in perceived competence in each of the 4 areas from 1997–1999 was examined as both a continuous variable and as a categorical variable with three groups (increased ≥ 2 points, changed by < 2 in either direction, or decreased ≥ 2 points). These categories were chosen based on the distribution of scores in the cohort. Over half of the cohort had little or no change in self-perception scores (change by 0 or 1 point) between 1997 and 1999, so a 2-point change appeared to represent a fairly substantial change over the time period.

Age—Age was calculated from date of birth and the date on which we received the completed questionnaire. Age was used as a continuous variable in all linear and logistic regression models.

BMI—Body mass index (BMI) was calculated from annual self-reported height and weight. From these measurements, BMI was then calculated as weight (kg) divided by height² (m²). Questionnaires gave specific measuring instructions and recommended asking for help in obtaining these measurements. Previous research found high validity for self-reported height and weight in adolescents.[15] Another study found a correlation of 0.92 between computed BMI from self-reported and measured height and weight.[16]

Cigarette smoking—In 1997 and 1999, all participants were asked the question, “Have you smoked a cigarette in the last month?” Answers to this question (yes/no) were used to define recent cigarette use.

Exercising for weight control—Participants responded to the question, “During the past year, to lose weight or to keep from gaining weight, how often did you exercise?” Possible responses included multiple time frequencies (never, < 1 time/month, 1–3 times/month, once/week, 2–6 times/week, and every day). Any response more frequent than ‘never’ was defined as having exercised for weight control.

Statistical Analyses

Physical activity and self-perception were examined by age for all participants aged 10–18 years in 1997 through 1999. Means and standard deviations were calculated for age, BMI, hours of activity per week and self-perception scores for both 1997 and 1999. The prevalence of past-month smoking and exercising for weight control were calculated for 1997 and 1999.

Linear regression was used to examine the effect of continuous change in physical activity on continuous change in each area of self-perception over the study period, adjusting for age, BMI, baseline activity level, baseline self-perception scores, past-month smoking, and exercising for weight control. Controlling for baseline activity and self-perception allowed us to examine the effect of activity independent of whether a participant had high or low activity levels or self-perception scores initially. We controlled for past-month smoking and exercising for weight control because we hypothesized that these might be potential confounders of the association between activity and self-perception.

Logistic regression was used to examine the effect of varying degrees of change in physical activity on self-perception scores for each area of the 4 areas studied, again adjusting for age, BMI, baseline activity level, baseline self-perception scores, past-month smoking, and exercising for weight control.

We fitted linear and logistic regression models using general estimated equations, which account for sibling clustering in the cohort. To determine if physical activity would affect boys and girls differently, all analyses were stratified by gender. Statistical analyses were performed using SAS version 8.2.[17]

Results

Table I presents the distribution of variables in 1997 and 1999. The average age was 12.9 (range 9.9–16.6) for girls and 12.8 (range 9.9–16.9 years) for boys in 1997, and 15.0 (range 11.8–18.6) and 14.8 (range 11.9–18.8 years) respectively in 1999. In general, girls reported fewer hours of physical activity than boys (12.2 hrs/wk compared to 14.7 hrs/wk in 1997, and 11.9 compared to 14.9 in 1999). The number of hours of physical activity stayed relatively stable (± 5 hours) from 1997–99 for the majority of girls (56%) and boys (48%). During this time period, 18% of girls and 25% of boys changed their activity levels by 10 or more hrs/wk. (either increased or decreased). Figure 2 shows the trends in physical activity by age among both boys and girls in the cohort. Among both girls and boys, activity appears to increase from ages 10 to 15 and steadily decline thereafter. No evidence of a cohort effect on physical activity was found.

For Figures 1 and 2, age was rounded down and used as a whole number, such that a participant aged 11.0 years and a participant aged 11.9 years would both be considered 11 years old. Ages were further combined such that anyone aged 14 in any of the years 1997, 1998, or 1999 was included in the age 14 category. Participants were therefore included in multiple age categories, based on their ages at the time that each questionnaire was completed. Because of the aging of the cohort, most participants were in the middle age categories (13, 14, 15) and fewer were in the youngest and oldest categories.

Comparing 1997 and 1999, self-perception scores also remained relatively stable. In each of the 4 areas of self-perception studied, at least 50% of participants changed less than 2 points. Figure 2 shows the age-related trends in social, athletic, global and scholastic self-perception scores among boys and girls from age 10 to 18 years. No evidence of a cohort effect was found.

For both girls and boys, linear regression models showed that increase in physical activity was positively associated with change in social and athletic self-perception scores ($p < 0.0001$) but was not associated with a change in either scholastic or global self-perception. (Table II)

Table III reports the odds ratios (OR) and 95% confidence intervals (CI) for change in self-perception score by 2 or more points compared to little or no change (0 or 1 point), by varying levels of activity. Those who increased their physical activity levels were more likely to have increased self-perception scores. (Table IIIa.) In girls this link was noted with social and athletic self-perception; those who increased their activity time by 5 or more hrs/wk were at least 33% more likely to have also increased their social self-perception (OR 1.33, 1.61), and at least 44% more likely to have also increased their athletic self-perception (OR 1.44, 2.05). In boys, there was a significant association with increased activity and increased social self-perception; those who increased activity by 10 or more hrs/wk were 45% more likely to have increased social self-perception. Conversely, those who decreased activity by 10 or more hours were significantly less likely to have increased self-perception. With this level of activity decrease, the OR for girls for increased athletic self-perception was 0.59, and the OR for boys for increased self-perception was 0.63 for social, and 0.56 for athletic.

Compared to those with little or no change, the odds of decreasing self-perception scores were greater among those with decreased physical activity levels. (Table IIIb) For girls who decreased activity by 5 or more hrs/wk, the odds of decreased social (OR 1.37, 1.66) and athletic (OR 1.37, 1.89) self-perception were significant. For boys, this relationship with decreased self-perception was seen among those who had an activity decrease of 10 or more hrs/wk (OR 1.44 for social, 1.89 for athletic). In girls and boys, those with increased activity of 5 or more hrs/wk were significantly less likely to have decreased athletic self-esteem (OR 0.70 and 0.57 for girls, 0.61 and 0.63 for boys).

No statistically significant associations between physical activity and either scholastic or global self-perception scores were found in girls or boys.

Discussion

Using longitudinal data, we found that increasing physical activity is positively associated with increased social and athletic self-perception scores among both girls and boys; the odds of increasing self-perception scores were over 30% higher in those who increased physical activity, compared to those with little or no activity change. In addition, decreased physical activity was associated with decreased athletic and social self-perception scores. These changes were seen across multiple categories of behavior change. (Table III)

No association was seen between physical activity change and either scholastic or global self-perception scores. Linear regression of 1-hour weekly activity change on change in self-perception scores, which showed significant association with social and athletic self-perception, showed no association with scholastic or global. (Table II) Previous work on these data also found no link between physical activity and perceived scholastic competence, but interestingly did show an association between eating breakfast and scholastic self-perception. [18]

A rapid decline in physical activity with age has been reported [1,19], especially in girls.[20–22] Our data did not show this rapid change in activity level, but did demonstrate a steady decline in activity starting at age 15 in both boys and girls.

Participants were asked about physical activity excluding gym/physical education. We hypothesized that, although the amount of physical activity done during gym class can vary widely, having gym/physical education class might affect the study's findings. In addition, inactive time, such as time spent watching television, might also have an impact. When we controlled for these factors, no statistically significant change was seen in any of the associations.

Self-concept is increasingly being studied as a collection of distinct elements that together make up an individual's sense of self. Using a variety of terms, such as self-esteem, self-concept, self-perception and self-image, research indicates that differentiated aspects of self-concept can be measured and evaluated in children and adolescents.[23–25] Our findings support the idea that self-concept is complex and multi-dimensional. The fact that changes in physical activity levels do not affect all types and measures of self-perception and perceived competence may help explain why an association has not been seen in all studies, particularly in those studies that looked at only a single measure of self-esteem. It has been proposed that, of the multiple factors that can affect self-esteem, those which are most valued by the individual may have greater influence on measures of self-esteem.[3] For example, physical activity may not affect self-esteem if an individual does not place great value on personal fitness. Especially in children who are focused on academic achievement, scholastic and global self-perception may be more closely tied to school performance rather than athletic involvement. However, for some adolescents, physical activity level clearly has a large impact on self-perception measures, and improved self-perception can be added to a long list of the benefits of being physically active.

Limitations

There are several limitations to this study. Because all participants are children of nurses, confounding as a result of socioeconomic factors is diminished, but not eliminated. Ninety four percent of the sample is white; therefore, our findings are not necessarily generalizable to people of color. Variations in physical activity patterns have been observed in different racial

and ethnic groups, [26,27] and the relationship between physical activity and self-perception measures may also differ. A strength of this study is that the cohort includes participants from all 50 states in the U.S., as well as residents of both urban and rural communities. While the results of this study may not be generalizable to the entire population, they do suggest that at least for some adolescents, physical activity affects multiple measures of self-perception.

Another limitation is that the potential for misclassification exists due to the fact that the data are collected through self report. However, self-reported data from other major longitudinal studies of adolescent health, including the Youth Risk Behavior Surveillance System and the Longitudinal Survey of Adolescent Health, have been shown to have reasonable validity and reliability. [28–31]

Because our data come from questionnaire responses, it was not possible to determine whether activities were part of group/organized team sport or individual activity. For example, the questionnaire asked about swimming and running, but these can be done either as part of a team or individual efforts. We were not able to determine if additional benefits were derived from social interactions surrounding the activity. In addition, we cannot assess if group or individual activities contributed differently to changes in self-perceptions. Additional research in this area is needed.

Another limitation of this study may result from the categorization of physical activity change. Five-hour increments were used because they represent 1 hour of activity 'on most days' of the week, as recommended in the Dietary Guidelines for Americans 2005 for children and adolescents.[32] Those participants whose activity levels changed less than 5 hrs/wk (either increased, decreased, or stayed the same) were combined to form the reference group. It is possible that by combining these participants into one group, some of the impact of positive or negative behavior change cannot be seen, and the findings have been biased toward the null. However, consistent links were seen with social and athletic self esteem. Future research may provide additional information on the benefits of specific activity frequency, intensity and duration.

Conclusion

Almost half of young Americans between the ages of 12–21 are not vigorously active on a routine basis, [1] and it has been estimated that, in general, children spend over 10 hours a day sedentary. [4] Especially as obesity rates continue to rise throughout the population, it is important to provide encouragement and opportunities for physical activity for all children.

Physical activity provides a myriad of health benefits, including the prevention of obesity [33] and multiple chronic diseases, and our research indicates that, for many adolescents, physical activity also offers the additional benefit of boosting both athletic and social self-perceptions.

Acknowledgements

We are grateful to the participants of the Growing Up Today Study. This study was funded by NIH grant DK46834, grant P30 DK46200 from the Boston Obesity Nutrition Research Center, and Kellogg's (Battle Creek, MI).

References

1. US Department of Health and Human Services. Physical Activity and Health: A Report of the Surgeon General. US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, The President's Council on Physical Fitness and Sports; Atlanta, GA: 1996.

2. Eyler AA, et al. The epidemiology of walking for physical activity in the United States. *Med Sci Sports Exerc* 2003;35(9):1529–36. [PubMed: 12972873]
3. Sonstroem RJ. Exercise and self-esteem. *Exerc Sport Sci Rev* 1984;12:123–55. [PubMed: 6376132]
4. Strauss RS, et al. Psychosocial correlates of physical activity in healthy children. *Arch Pediatr Adolesc Med* 2001;155(8):897–902. [PubMed: 11483116]
5. Butcher J. Socialization of adolescent girls into physical activity. *Adolescence* 1983;18(72):753–66. [PubMed: 6666702]
6. Sherrill C, Holguin O, Caywood AJ. Fitness, attitude toward physical education, and self-concept of elementary school children. *Percept Mot Skills* 1989;69(2):411–4. [PubMed: 2812984]
7. Ferguson KJ. Attitudes, knowledge, and beliefs as predictors of exercise intent and behavior in schoolchildren. *J Sch Health* 1989;59(3):112–5. [PubMed: 2704183]
8. Page RM, Tucker LA. Psychosocial discomfort and exercise frequency: an epidemiological study of adolescents. *Adolescence* 1994;29(113):183–91. [PubMed: 8036975]
9. Sallis JF, Prochaska JJ, Taylor WC. A review of correlates of physical activity of children and adolescents. *Med Sci Sports Exerc* 2000;32(5):963–75. [PubMed: 10795788]
10. Berkey CS. Activity, dietary intake, and weight changes in a longitudinal study of preadolescent and adolescent boys and girls. *Pediatrics* 2000;105(4):E56. [PubMed: 10742377]
11. Peterson, K. Validation of YRBSS Questions on Dietary Behaviors and Physical Activity Among Adolescents in Grades 9–12. 1996. Prepared for Centers for Disease Control and Prevention, Division of Adolescent and School Health: Atlanta, GA
12. Gortmaker SL, et al. Reducing obesity via a school-based interdisciplinary intervention among youth: Planet Health. *Arch Pediatr Adolesc Med* 1999;153(4):409–18. [PubMed: 10201726]
13. Rifas-Shiman SL, et al. Comparing physical activity questionnaires for youth: seasonal vs annual format. *Am J Prev Med* 2001;20(4):282–5. [PubMed: 11331117]
14. Harter, S. Manual for the Self-Perception Profile for Children. Denver, CO: University of Denver; 1985.
15. Strauss RS. Comparison of measured and self-reported weight and height in a cross-sectional sample of young adolescents. *Int J Obes Relat Metab Disord* 1999;23(8):904–8. [PubMed: 10490794]
16. Goodman E, Hinden BR, Khandelwal S. Accuracy of teen and parental reports of obesity and body mass index. *Pediatrics* 2000;106(1 Pt 1):52–8. [PubMed: 10878149]
17. SAS. The SAS Institute, Inc; Cary, NC: 1999.
18. Berkey CS, et al. Longitudinal study of skipping breakfast and weight change in adolescents. *Int J Obes Relat Metab Disord* 2003;27(10):1258–66. [PubMed: 14513075]
19. Heath GW, et al. Physical activity patterns in American high school students. Results from the 1990 Youth Risk Behavior Survey. *Arch Pediatr Adolesc Med* 1994;148(11):1131–6. [PubMed: 7921112]
20. Kimm SY, et al. Longitudinal changes in physical activity in a biracial cohort during adolescence. *Med Sci Sports Exerc* 2000;32(8):1445–54. [PubMed: 10949011]
21. Kimm SY, et al. Decline in physical activity in black girls and white girls during adolescence. *N Engl J Med* 2002;347(10):709–15. [PubMed: 12213941]
22. Aaron DJ, et al. The epidemiology of leisure physical activity in an adolescent population. *Med Sci Sports Exerc* 1993;25(7):847–53. [PubMed: 8350708]
23. Butler R, Gasson S. Self Esteem/Self Concept Scales for Children and Adolescents: A Review. *Child and Adolescent Mental Health* 2005;10(4):190–201.
24. Marsh H. Age and Sex Effects in Multiple Dimensions of Self-Concept: Preadolescence to Early Adulthood. *Journal of Educational Psychology* 1989;81(3):417–430.
25. Evans D. Self-Complexity and Its Relation to Development, Symptomatology and Self-Perception During Adolescence. *Child Psychiatry and Human Development* 1994;24(3):173–182. [PubMed: 8174394]
26. Wolf AM, et al. Activity, inactivity, and obesity: racial, ethnic, and age differences among schoolgirls. *Am J Public Health* 1993;83(11):1625–7. [PubMed: 8238692]
27. Sallis JF, et al. Ethnic, socioeconomic, and sex differences in physical activity among adolescents. *J Clin Epidemiol* 1996;49(2):125–34. [PubMed: 8606313]

28. Hornberger L, et al. Sexual histories of adolescent girls: comparison between interview and chart. *Journal of Adolescent Health* 1995;16:235–239. [PubMed: 7779835]
29. Kahn JA, et al. Validity of adolescent and young adult self-report of Papanicolaou smear results. *Obstet Gynecol* 2000;96(4):625–31. [PubMed: 11004371]
30. Shew ML, et al. The validity of self-reported condom use among adolescents. *Sex Transm Dis* 1997;24(9):503–10. [PubMed: 9339967]
31. Brener ND, et al. Reliability of the 1999 youth risk behavior survey questionnaire. *J Adolesc Health* 2002;31(4):336–42. [PubMed: 12359379]
32. US Department of Health and Human Services and US Department of Agriculture. *Dietary Guidelines for Americans*, 2005. 6. Washington, DC: US Government Printing Office; 2005.
33. Berkey CS, et al. One-year changes in activity and in inactivity among 10- to 15-year-old boys and girls: relationship to change in body mass index. *Pediatrics* 2003;111(4 Pt 1):836–43. [PubMed: 12671121]

Figure 1.
Weekly hours of physical activity among boys and girls by age (pooled)

Figure 2.
Age trends of self-perception measures among girls and boys.

Table I

Distribution of variables 1997 and 1999

	Girls (n=5260)		Boys (n=3410)	
	Mean (standard deviation)			
	1997	1999	1997	1999
Age	12.9 (±1.6)	15.0 (±1.6)	12.8 (±1.6)	14.8 (±1.6)
BMI	19.6 (±3.3)	20.8 (±3.2)	19.7 (±3.4)	21.2 (±3.6)
Hours of activity/week	12.2 (±8.0)	11.9 (±7.7)	14.7 (±8.5)	14.9 (±8.7)
Self-perception score				
Social	14.4 (±2.6)	14.6 (±2.5)	14.4 (±2.8)	14.5 (±2.6)
Athletic	13.0 (±2.7)	12.8 (±2.8)	13.8 (±2.6)	13.8 (±2.6)
Scholastic	15.0 (±2.3)	15.1 (±2.4)	15.1 (±2.3)	15.2 (±2.5)
Global	15.3 (±2.7)	15.2 (±2.7)	15.7 (±2.4)	15.6 (±2.5)
	Number (%)			
	1997	1999	1997	1999
Physical activity change (hours/week)				
Increased >10		454 (9%)		428 (13%)
Increased 5–10		672 (13%)		493 (15%)
Changed < 5		2927 (56%)		1648 (48%)
Decreased 5–10		711 (13%)		417 (12%)
Decreased >10		496 (9%)		424 (12%)
	Number (%)			
	1997	1999	1997	1999
Past month smoking	229 (4%)	489 (9%)	105 (3%)	194 (6%)
Exercising for weight control	509 (10%)	501 (10%)	278 (8%)	220 (7%)

Table II
Linear regression of one-hour change in weekly physical activity from 1997–1999 on change in self-perception scores 1997–1999

Beta, p-value *				
	Social	Athletic	Scholastic	Global
Girls				
Change in activity	0.031, p<0.0001	0.067, p<0.0001	0.001, p=0.8606	<0.001 p=0.9459
Boys				
Change in activity	0.033, p<0.0001	0.049, p<0.0001	0.003, p=0.5383	0.005, p=0.2635

* Adjusted for sibling clustering, age, BMI, baseline activity, baseline self-perception scores, past month smoking, and exercising for weight control.

Odds ratios for increasing self-perception scores by 2 or more points vs. little or no change (0 or 1 point change) 1997–1999

Table III a

Odds ratio [95% CI]				
	Social	Athletic	Scholastic	Global
Girls				
Change in weekly activity 1997–1999				
Increased 10+ hrs	1.33 [1.02–1.75]	2.05 [1.60–2.61]	0.92 [0.69–1.22]	1.04 [0.77–1.40]
Increased 5–10 hrs	1.61 [1.29–2.00]	1.44 [1.16–1.79]	1.10 [0.88–1.39]	1.05 [0.82–1.34]
Stayed same (<5 hr change)	1.0	1.0	1.0	1.0
Decreased 5–10 hrs	1.03 [0.81–1.31]	0.82 [0.63–1.05]	0.91 [0.71–1.17]	1.04 [0.81–1.34]
Decreased 10+ hrs	1.02 [0.74–1.42]	0.59 [0.42–0.83]	1.08 [0.77–1.52]	0.73 [0.51–1.05]
Boys				
Change in weekly activity 1997–1999				
Increased 10+ hrs	1.45 [1.08–1.97]	1.27 [0.97–1.67]	1.05 [0.78–1.42]	0.93 [0.66–1.32]
Increased 5–10 hrs	1.23 [0.93–1.63]	1.19 [0.92–1.53]	0.82 [0.62–1.08]	0.88 [0.64–1.20]
Stayed same (<5 hr change)	1.0	1.0	1.0	1.0
Decreased 5–10 hrs	1.14 [0.84–1.57]	0.65 [0.47–0.88]	0.94 [0.68–1.28]	0.91 [0.64–1.27]
Decreased 10+ hrs	0.63 [0.43–0.92]	0.56 [0.40–0.80]	0.96 [0.68–1.37]	0.79 [0.54–1.16]

Adjusted for sibling clustering, age, BMI, baseline activity, baseline self-perception, past month smoking, and exercising for weight control.

Odds ratios for decreasing self-perception scores by 2 or more points vs. little or no change (0 or 1 point change) 1997–1999

Table III b

Odds ratio [95% CI]				
	Social	Athletic	Scholastic	Global
Girls				
Change in weekly activity 1997–1999				
Increased 10+ hrs	0.88 [0.67–1.15]	0.57 [0.43–0.75]	1.16 [0.90–1.49]	1.24 [0.97–1.57]
Increased 5–10 hrs	0.82 [0.65–1.03]	0.70 [0.57–0.87]	1.06 [0.85–1.32]	0.93 [0.75–1.15]
Stayed same (<5 hr change)	1.0	1.0	1.0	1.0
Decreased 5–10 hrs	1.37 [1.10–1.71]	1.37 [1.12–1.67]	1.05 [0.84–1.30]	1.15 [0.93–1.43]
Decreased 10+ hrs	1.66 [1.23–2.23]	1.89 [1.43–2.50]	1.27 [0.95–1.71]	1.31 [0.99–1.73]
Boys				
Change in weekly activity 1997–1999				
Increased 10+ hrs	0.77 [0.59–1.02]	0.63 [0.48–0.83]	1.18 [0.89–1.56]	0.93 [0.72–1.21]
Increased 5–10 hrs	0.99 [0.77–1.28]	0.61 [0.46–0.80]	1.00 [0.77–1.30]	0.84 [0.65–1.09]
Stayed same (<5 hr change)	1.0	1.0	1.0	1.0
Decreased 5–10 hrs	1.17 [0.88–1.56]	1.17 [0.88–1.55]	0.98 [0.74–1.31]	0.78 [0.58–1.03]
Decreased 10+ hrs	1.44 [1.06–1.94]	1.89 [1.39–2.58]	1.08 [0.78–1.49]	0.89 [0.66–1.21]

Adjusted for sibling clustering, age, BMI, baseline activity, baseline self-perception, past month smoking, and exercising for weight control.