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Sport participation, physical activity and sedentary behavior in the transition from middle school to high school

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Abstract

Objective: To examine associations between sport participation, and objectively assessed physical activity and sedentary behavior in youth during the transition from middle school to high school.

Design: Longitudinal study with 2-year follow-up.

Methods: Sport participation and accelerometer-measured physical activity and sedentary behavior were assessed in 306 children (122 males, 184 females) when they were in 7th and 9th grades (mean age of 12.5 ± 0.5 years).

Results: Sport participation and physical activity declined from 7th to 9th grade, but total physical activity (d = 0.38, p <0.0001) and moderate-to-vigorous physical activity (d = 0.26, p = 0.0004) remained higher in sport participants compared to non-participants. In 9th grade, the full sample of sport participants compared to non-participants had higher levels of total physical activity (20.7 min/hr vs. 18.5 min/hr) and moderate-to-vigorous physical activity (1.8 min/hr vs. 1.6 min/hr). Sex-specific analysis revealed similar patterns in both females and males. Sedentary behavior remained lower (d = −0.37, p = <0.0001) in the full sample of sport participants compared to non-participants (39.8 min/hr vs. 41.7 min/hr) in 9th grade. Similar patterns were observed in both females and males.

Conclusions: Children's participation in sport is associated with greater levels of physical activity and lower levels of sedentary behavior during the transition from middle school to high school. Promoting children's participation in sports could be an effective public health strategy to help children meet the current physical activity guideline.

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Keywords

children; youth, students; participants; activities; exercise

Introduction

Physical activity provides important health benefits to children and youth,[1] and national guidelines recommend that school-aged youth accumulate 60 minutes of moderate-to-vigorous physical activity (MVPA) each day.[2] However, less than a quarter of U.S. youth, aged 6 to 19 years, meet that physical activity recommendation.[3] Compounding this problem, research shows that rates of compliance with physical activity recommendations decrease markedly during the transition from childhood to adolescence.[4] These trends represent major public health challenges, and effective strategies for increasing physical activity among children and youth are greatly needed.

The U.S. Department of Health & Human Services and the World Health Organization have pointed to sport participation as an important strategy for promoting physical activity in youth.[5,6] Sport participation is a subset of physical activity and youth sport has been defined as a program that provides a systematic sequence of practices and contests for children and youth.[7] Cross-sectional studies have consistently shown that participants in youth sport programs tend to be more physically active, expend more energy, and spend more time in MVPA than their non-sport participant peers.[8] Similarly, children are more active when involved in organized school sport programs.[9–11] However, studies also show that children tend to drop out of sport programs as they transition from childhood to adolescence.[12] Multiple reasons for drop out from sport have been identified, including lack of enjoyment, time constraints, and lack of opportunities for participation.[7] The observed trends found in the literature suggest that children who participate in sport programs during middle school and maintain participation through high school would be expected to sustain higher levels of physical activity than children who do not participate.

The hypothesis that sustained sport participation is associated with higher levels of physical activity has rarely been examined as children transition from middle to high school in the U.S. The existing research literature is limited by a lack of longitudinal cohort studies in which both objectively assessed physical activity and information on sport participation are available. The present study addresses this gap by examining the associations between sport participation and objectively assessed physical activity in youth during the transition from middle to high school. In addition, because of rising concerns about the health effects of excessive sedentary behavior in youth,[13] the study also examined associations between sport participation and time spent in sedentary behavior.

Methods

Data for the present study were drawn from a longitudinal study of age-related change in objectively assessed physical activity among children, ages 12–17 years, in two South Carolina school districts (13 middle schools and 9 high schools). Details regarding the overall study protocol are reported elsewhere.[14] Prior to the study, written informed consent

and assent were obtained from the primary guardian and each child. The University of South Carolina's institutional review board approved all protocols. Sport participation and accelerometry data were available for 765 children in 7th grade. Sport participation data were available for 308 children and accelerometry data were available for 220 children in the 9th grade. Two children were deleted because of missing parent education data, yielding a final analysis sample of 306 children (122 males and 184 females). There were no race, ethnicity or sex differences between those included (n = 306) and excluded (n = 458), nor did those with (n=220) and without (n=86) accelerometry data in 9th grade differ on 7th grade accelerometry data.

Children's physical activity and sedentary behavior were assessed by accelerometry (Actigraph models GT1M and GT3X, Fort Walton Beach, FL). Children were instructed to wear the accelerometer for seven consecutive days during most waking hours (except during water-based activities). Prior to data collection, the accelerometers were initialized to begin collecting data at 5:00 a.m. on the day following monitor distribution. Data were collected and stored in 60-second epochs, and any period of ≥ 60 minutes of consecutive zero counts was defined as non-wear time. Age-specific movement count thresholds were used to distinguish between sedentary, MVPA and total physical activity.[15] The following cut-points and corresponding thresholds were used: sedentary < 100 counts per minute, MVPA ≥ 2200 counts per minute, and total physical activity as > 100 counts per minute. Missing values were estimated using a sex-specific multiple imputation technique via SAS PROC MI, for children who had at least two days of eight hours of accelerometer wear time. Physical activity and sedentary behavior variables were reported as minutes of each behavior per hour of observation.

Sport participation was assessed by questionnaires completed by children in 7th and 9th grades. For the 7th grade survey, children recorded participation on 16 school or community sport teams in the past year (Yes or No). For the 9th grade survey, they indicated participation in the same 16 school or community sport teams in the past year. A child was classified as a sport 'participant' (≥ 1 sport) or 'non-participant' (< 1 sport) at each grade level for the present analyses. Children's height and weight measurements were obtained by trained staff using standard protocols. Body mass index (BMI) was then calculated by dividing the weight (kilograms) by height (meters squared). Maturity offset was calculated using gender-specific equations[16,17] to predict peak height velocity using the children's anthropometric measurements. A negative maturity offset value signifies the number of years the child is from reaching peak height velocity, while a positive maturity offset signifies the number of years a child is beyond peak height velocity. Maturity offset at the 7th grade was included as a covariate in the analyses.

Children reported their age, sex, grade level, and race/ethnicity via a child survey instrument. For race, the child selected from the categories provided (i.e., American Indian or Alaskan Native, Black/African American, Native Hawaiian, Pacific Islander, White, Asian or other). Due to the small numbers of Asian, American Indian or Alaskan Native, and other or mixed-race children, these categories were collapsed into a single category labeled as 'other'. In a parent survey, parents reported their highest level of education (i.e., attended high school, completed high school, attended college or technical school, completed college

or technical school, attended graduate school, or completed graduate school). Parent level of education was re-coded as ‘high school or less’ and ‘more than high school’ to use as an indicator of child’s socio-economic status.

Descriptive statistics (means and standard deviations or percentages) were calculated to describe the sample characteristics. A repeated measures linear regression analysis was used to determine if levels of physical activity and sedentary behavior differed between sport participants and non-participants from 7th to 9th grade by sex. Interactions between sport participation and grade level were also examined. All analyses were adjusted for race/ethnicity, parent education and maturity, with the addition of adjusting for gender in the total group analysis. Additionally, children were nested in middle school of attendance in all analyses. Cohen’s d effect size (d) was calculated to estimate the magnitude of the differences between groups.[18] The effect sizes (d) for magnitude of differences between grade equaled the change over time in the 9th grade group minus the change over time in the 7th grade group, divided by the pooled standard deviations. The effect sizes (d) for the magnitude of differences between sport participation equaled change over time in the sport participants minus the change over time in the non-participants, divided by the pooled standard deviations. Effect sizes of d=0.20 were considered small, d=0.50 medium, and d=0.80 large.[18] To correct skewness, square root transformations were used for MVPA in calculating p-values. Statistical significance was set at $p < 0.05$. Analyses were performed using SAS 9.4 Statistical software (SAS Institute, Cary, NC).

Results

The total sample consisted of 306 students with a mean age of 12.5 ± 0.5 years. Seventh grade females were beyond predicted peak height velocity (maturity offset mean of 0.70 ± 0.57), while males were approximately a year (−1.09 ± 0.75) from reaching predicted peak height velocity. The sample had a mean BMI of 22.8 kg/m^2 (± 5.8 kg/m^2) and a mean BMI percentile of 71.9 (± 25.9) in 7th grade (see Table 1). Approximately 40% of participants were male, and the racial/ethnic composition was 44% African American, 31% White, 8% Hispanic and 17% other. Over half of the children’s parents (55.6%) had completed education post high school. In 7th grade a majority of participants (74.2%) reported participating in sports, with a slightly larger percentage of males (76.2%) participating than females (72.8%). In 9th grade less than half of participants (46.7%) reported participating in sports, with a larger percentage of males (50.8%) participating than females (45.7%).

Table 2 displays repeated measures regression results comparing sport participants and non-participants in the full sample on total physical activity, MVPA and sedentary behavior. As expected, physical activity declined with increasing age and grade and the rate of decline was comparable to that previously reported.[14,19] Declines in physical activity occurred for both sport participants and non-participants during the transition from 7th grade to 9th grade. However, physical activity levels remained higher over time in sport participants compared to non-participants (see Table 3). Sport participants had significantly higher levels of total physical activity (d = 0.38, p <0.0001) and MVPA (d = 0.26, p = 0.0004) compared to non-participants. Similar results were observed for females for total physical activity (d = 0.33, p

= 0.006) and MVPA (d = 0.25, p = 0.02) and for males for total physical activity (d = 0.40, p = 0.006) and MVPA (d = 0.33, p = 0.007) (see Table 3).

In addition, sedentary behavior remained lower over time for sport participants compared to non-participants for the total group (d = −0.37, p = <0.0001) (see Table 2). Similar results were obtained for female (d = −0.32, p = 0.009) and male (d = −0.46, p = 0.003) sport participants compared to non-participants (see Table 3). The rate of increased sedentary behavior over time was consistent with previous findings.[19,20] No significant grade by group interactions were found. Analyses were repeated for the 220 children who had accelerometer data at both 7th and 9th grade, with little change in the findings.

Discussion

The key finding of this study was that, in a diverse sample of middle school and high school students, sport participation was consistently associated with higher levels of objectively assessed physical activity. In the total group, sport participants compared to non-participants had higher levels of total physical activity and MVPA in the transition from middle school to high school. Even though physical activity declined during the transition from 7th grade to 9th grade, male and female sport participants maintained higher levels of physical activity compared to non-participants. These findings are consistent with findings of previous cross-sectional and longitudinal studies, in which children who participated in sports tended to be more active[21–26] than their peers who did not participate in sports. For example, in a cross sectional study, Marques and colleagues reported that sport participants spent more time in moderate and vigorous intensity physical activity than non-participants (OR=1.01, 95% CI: 1.01–1.02, p<0.001).[23] Similarly, in a longitudinal examination of sports club participation and physical activity in Australian youth, aged 8–16 years, Telford and colleagues reported that sports club participants were more physically active compared to non-participants, in all age groups.[24] The findings of the present study extend previous reported results by identifying a relationship between sport participation and objectively assessed physical activity among U.S. youth transitioning from middle school to high school.

In recent years, sedentary behavior has been found to be associated with health risks in youth, independent of their participation in physical activity.[27] The present study demonstrated that sport participation was consistently associated with lower levels of sedentary behavior in youth transitioning from middle school to high school. We found that sport participants compared to non-participants had lower levels of sedentary behavior for the total group and in both sexes. These results are consistent with the findings of previous cross-sectional and longitudinal studies. Those previous studies reported that children who participated in sport spent less time engaged in sedentary activity[24,28] and reported fewer time blocks of sedentary behavior[21] compared with their peers who did not participate in sport. Therefore, increasing sport participation could be an important public health strategy for reducing sedentary behavior during this transitional period for youth.

The findings of the present study support the conclusion that children who are involved in sport spend more time being physically active and less time in sedentary behavior than their peers who are not sport participants. However, the design and methodology of the study do

not allow us to identify the underlying factors that explain why these patterns were observed. There are several possible explanations. One is that, because organized sport practices and contests typically involve physical activity, time spent in sport may replace time that children would otherwise spend in sedentary pursuits.[29] It is also possible that sport participation provides children with enjoyable physical activity experiences that influence their decisions about how to use their discretionary time outside of formal, organized sport settings. That is, sport participants may tend to commit time to sport and/or exercise training during their free time. It is also possible that children who opt into sport participation are, by virtue of early life experiences and/or genetic profiles, fundamentally more physical active than children who are not attracted to sport. Future studies should aim to elucidate the factors that explain the impact of sport participation on children's overall physical activity levels.

The findings of this study suggest that efforts to promote physical activity and reduce sedentary behavior should include activities that support and increase sport participation during adolescence. Previous legislative and policy actions have demonstrated that increasing opportunities for sport participation leads to increased sport participation, and subsequently to increased physical activity. Title IX, for example, dramatically increased U.S. girls' sport participation following its passage in 1972, and studies have shown that high school girls who are involved in school sports are more physically active than non-participants.[30] However, youth tend to drop out of sports as they move into and through adolescence, and studies have identified a number of factors associated with youth sport dropout. These include lack of enjoyment, perceived incompetence, social pressures, competing priorities, and physical factors[12] As children move into and through adolescence, special efforts should be made by those working with youth, in the school and community, to help them find sport opportunities that they can continue into high school. The findings of this study suggest that youth who avoid dropout and continue to participate in sports into high school have higher levels of physical activity and lower levels of sedentary behavior. Specific actions, such as implementing policies that aim to expand sport programs, providing a greater variety of opportunities, and including more non-competitive programs, should be taken by schools and communities to increase youth sport participation and to reduce dropout rates.

To our knowledge, this was the first longitudinal study in the U.S. to examine sport participation, objectively assessed physical activity, and sedentary behavior in a sample of 7^{th} and 9^{th} graders. Major strengths of this study include a prospective longitudinal study design and device-based measurement of physical activity and sedentary behavior. However, several limitations should be considered. Sport participation was self-reported by youth and hence there was a potential of recall bias, and no distinctions were made between school and community-based sport participation. Additionally, no differentiations were made on the basis of the type of sport, frequency of sport participation (e.g., practices or games per week), or number of teams participated on per year. Future longitudinal studies should include examination of these additional sport participation characteristics. Lastly, the present study was conducted in only two school districts in one U.S. state, and this may limit the generalizability of the results.

Conclusion

Children who consistently engaged in sport were more active than their non-participating peers. Because sport provides a way for children to be active, policies should support the growth and availability of sporting opportunities for children of all interests and ability levels. This could potentially help offset the age-related decline in physical activity that typically occurs from middle school to high school. Promoting and encouraging children to participate in sports may be part of an effective public health strategy to help children meet the current physical activity guideline of 60 minutes of MVPA per day. Future research should employ experimental study designs in testing the effects of increasing sport opportunities on sport participation, physical activity, and sedentary behavior levels during this transitional period for youth.

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Practical Implications

- Participation in sport provides a viable way for children and adolescents to be more physically active and engage in less sedentary behavior.
- Promoting youth sport participation during the transition from middle school to high school could help off-set the age-related decline in physical activity typically seen in these age groups.
- Policies should support the growth and availability of sport programs to help children of all interests and ability levels meet the recommended daily amounts of physical activity.

Table 1.

Sample Characteristics by Total Group and Sex.

	Total Group (n=306)	Males (n=122)	Females (n=184)	p-value
Age (years)	12.5 ± 0.5	12.5 ± 0.5	12.4 ± 0.5	0.2
Maturity offset	−0.02 ± 1.09	−1.09 ± 0.75	0.70 ± 0.57	<0.001
BMI (kg/m^2)	22.8 ± 5.8	21.7 ± 5.5	23.5 ± 6.0	0.01
BMI percentile	71.9 ± 25.9	67.3 ± 28.7	74.9 ± 23.4	0.01
Race				
White	94 (30.7%)	33 (27.1%)	61 (33.2%)	
African American	135 (44.1%)	55 (45.1%)	80 (43.5%)	0.6
Hispanic	25 (8.2%)	10 (8.2%)	15 (8.2%)	
Other	52 (17.0%)	24 (19.7%)	28 (15.2%)	
Parent education				
High school or less	136 (44.4%)	48 (39.3%)	88 (47.8%)	0.1
Greater than high school	170 (55.6%)	74 (60.7%)	96 (52.2%)	
Sport participation				
Non-participant	79 (25.8%)	29 (23.8%)	50 (27.2%)	0.5
Participant	227 (74.2%)	93 (76.2%)	134 (72.8%)	

Data is shown as mean (standard deviation or percentage).

Age, maturity offset, BMI, BMI percentile and sport participation values are for the 7th grade.

BMI, body mass index.

Table 2.

Results from Repeated Measures Linear Regression Analysis of Sport Participation and Physical Activity from 7th to 9th Grade for the Total Group (n=306).

Physical Activity (min/hr)	Sport Participants		Non-Participants		Sport Participation		Grade	
	7th Grade (n=227)	**9th Grade** (n=79)	**7th Grade** (n=79)	**9th Grade** (n=123)	d	p-value	d	p-value
Total Physical Activity	23.3 (0.3)	20.7 (0.5)	21.3 (0.5)	18.5 (0.4)	0.38	**<0.0001**	−0.56	**<0.0001**
MVPA	2.7 (0.1)	1.8 (0.2)	2.0 (0.2)	1.6 (0.2)	0.26	**0.0004**	−0.38	**<0.0001**
Sedentary	36.9 (0.3)	39.8 (0.4)	38.4 (0.5)	41.7 (0.4)	−0.37	**<0.0001**	0.68	**<0.0001**

Data is shown as Least Square Means (SE).

d = effect size d.

Bolded p-values (<0.05) indicate significant result.

Controlling for race/ethnicity, parent education, gender and maturity.

Children nested in middle school.

MVPA, moderate-to-vigorous physical activity.

Table 3.

Results from Repeated Measures Linear Regression Analysis of Sport Participation and Physical Activity from 7th to 9th Grade by Sex.

Males (n=122)								
Physical Activity (min/hr)	**Sport Participants**		**Non-Participants**		**Sport Participation**		**Grade**	
	7th Grade (n=93)	**9th Grade** (n=45)	**7th Grade** (n=29)	**9th Grade** (n=46)	d	p-value	d	p-value
Total Physical Activity	24.5 (0.6)	22.1 (0.8)	22.3 (1.0)	19.8 (0.8)	0.40	**0.006**	−0.45	**0.001**
MVPA	3.4 (0.3)	2.4 (0.4)	2.3 (0.4)	2.2 (0.3)	0.33	**0.007**	−0.16	**0.001**
Sedentary	35.6 (0.6)	38.5 (0.7)	37.7 (0.9)	41.0 (0.7)	−0.46	**0.003**	0.89	**<0.0001**
Females (n=184)								
Physical Activity (min/hr)	**Sport Participants**		**Non-Participants**		**Sport Participation**		**Grade**	
	7th Grade (n=134)	**9th Grade** (n=52)	**7th Grade** (n=50)	**9th Grade** (n=77)	d	p-value	d	p-value
Total Physical Activity	22.0 (0.4)	19.2 (0.6)	20.6 (0.6)	17.6 (0.5)	0.33	**0.006**	−0.71	**<0.0001**
MVPA	2.0 (0.1)	1.1 (0.2)	1.6 (0.2)	1.0 (0.1)	0.25	**0.02**	−0.65	**<0.0001**
Sedentary	38.1 (0.4)	41.1 (0.6)	39.4 (0.6)	42.7 (0.5)	−0.32	**0.009**	0.78	**<0.0001**

Data is shown as Least Square Means (SE).

Bolded p-values (<0.05) indicate significant result.

d = effect size d.

Controlling for race/ethnicity, parent education and maturity.

Children nested in middle school.

MVPA, moderate-to-vigorous physical activity.