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Psychosocial Correlates of Physical and Sedentary Activities of Early Adolescent Youth

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Abstract

This study examines physical and sedentary activities of early adolescent boys and girls using Ecological Momentary Assessment (EMA), a method that can link mood and behaviors in specific social situations. Twenty-seven assessments were collected across seven days from 82 participating adolescents, three times in seventh grade and one time in eighth grade. Assessments were completed during nonschool hours when youth had "free time." Gender differences, longitudinal trends, and associations of physical activities (PA) and small screen recreation (SSR) with moods and peer presence are examined. Boys were engaged in PA more than girls. Patterns of PA differed by gender; boys significantly decreased PA from seventh to eighth grade, whereas girls had increased PA only during the spring. PA was associated with happier mood and was more likely to occur in the presence of peers. SSR significantly increased from seventh grade to eighth grade for both boys and girls. SSR occurred more when youth were alone, and was not associated with mood. Neither PA nor SSR were more likely to occur during weekdays or weekends. Implications for intervention efforts to increase PA in youth are discussed.

Keywords

Ecological Momentary Assessment; middle school youth; physical activity; sedentary activity

Rapidly increasing rates of childhood and adolescent obesity have fueled research on modifiable factors associated with weight gain, including barriers and facilitators of physical activity in youth. The World Health Organization recommends that children and youth engage in at least 60 minutes of moderate to vigorous physical activity daily (World Health Organization, 2010), and the American Academy of Pediatrics recommends limiting sedentary screen time (e.g., watching television, playing video games) to 2 or fewer hours per day (American Academy of Pediatrics, 2009). However, most youth do not engage in sufficient physical activity and many exceed recommendations for sedentary activity (Eaton et al., 2010; Gordon-Larsen, Nelson, & Popkin, 2004; Guthold, Cowan, Autenrieth, Kann, & Riley, 2010). Moreover, physical activity tends to decline during adolescence (Kahn et al., 2008; Sallis, Prochaska, & Taylor, 2000) and youth engagement in sedentary media-related activities (e.g., watching television, playing video games, using computers) has significantly increased over the last 10 years (Rideout, Foehr, & Roberts, 2010). Engaging in less physical activity and more sedentary activity than recommended is a significant risk factor for becoming overweight or obese (Andersen, Crespo, Bartlett, Cheskin, & Pratt, 1998; Patrick et al., 2004; Strong et al., 2005), which is associated with numerous health problems (Institute of Medicine, 2012). Developing healthy habits in children and adolescents has therefore become a public health priority (Institute of Medicine, 2012).

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Unfortunately, a recent meta-analysis of intervention studies to promote physical activity in youth found very small or nonsignificant effects (Metcalf, Henley, & Wilkin, 2012). Given the lack of success in the efforts to increase physical activity in youth, we need to gain a better understanding of effective ways to intervene. The social learning theory suggests that peers are a salient influence on behavioral development of adolescents (e.g., Dishion, Patterson, & Griesler, 1994; Iaccard, Blanton, & Dodge, 2005; Kiesner, Dishion, & Pouline, 2001; Patterson, Reid, & Dishion, 1992). We expect to find a link between peer support and physical activities for middle school youth, given the importance of peer acceptance for middle school youth, particularly for girls (Kingery, Erdley, & Marshall, 2011; Ladd, Kochenderfer, & Coleman, 1997). Intervention studies focused on increasing physical activity in middle school-age girls suggest that peers play a role in supporting their physical activity. For middle school girls, peer support was more helpful than parent support in increasing physical activity (Lytle et al., 2009). Also, perceived social support had a positive impact on sixth grade girls' physical activity, but not eighth grade girls (Dishman, Dunn, Sallis, Vandenberg, & Pratt, 2009). Further evidence is needed regarding peer influence on physical activity. Peers also may play a role in influencing the amount of time spent engaged in sedentary activities.

A number of intervention studies have focused on increasing physical activity in girls as a gender discrepancy in physical activity levels in youth has been found; boys spend more time in physical activity and less time in sedentary activities compared to girls (Guthold et al., 2010; Robbins, Sikorskii, Hamel, Wu, & Wilbur, 2009; Sallis et al., 2000). There is also evidence that boys have a steeper decline in physical activity than girls between ages 13–18 (Sallis, 2000; van Mechelen et al., 2000), resulting in girls' activity levels surpassing that of boys in late adolescence (Kahn et al., 2008). These findings support the benefit of efforts to promote and facilitate physical activity in both middle school boys and girls.

Understanding how adolescent mood is associated with physical and sedentary activity may also suggest novel ways to prevent mood disorders and behavioral problems in youth. Emotional states become less positive and more variable during adolescence (Larson, Moneta, Richards, & Wilson, 2002). Negative and fluctuating moods are associated with depression and externalizing behavior problems (Eisenberg et al., 1997, 2001; Silk, Steinberg, & Morris, 2003). Emerging evidence demonstrates a positive impact of physical activity on adolescent mood. An inverse relationship was found between adolescents' physical activity and depression in three out of four studies reviewed (Sallis et al., 2000). Sund and colleagues (2011) found a concurrent association between low levels of vigorous physical activity and depressive symptoms for adolescents, and a predictive relationship for adolescent boys one year later, but not for girls. Increases in physical activity between seventh and eighth grade predicted lower depression in eighth grade boys and girls (Motl, Birnbaum, Kubik, & Dishman, 2004). An inverse relationship was also found between adolescent-reported sedentary activity and psychological well-being for both boys and girls, even when controlling for academic performance and sociodemographic and health factors (Ussher, Owen, Cook, & Whincup, 2007).

Ecological Momentary Assessment (EMA) provides numerous advantages for measuring the contextual and intrapersonal factors associated with particular behaviors in youth. With EMA these measures are collected concurrently in real time and in natural settings. In typical survey studies, such data are collected via retrospective self-report questionnaires, which are fraught with biases such as recency and saliency effects (Gorin & Stone, 2001; Schwarz & Sudman, 1994; Shiffman, 2000); one tends to report events or phenomena that are more recent and more readily recalled due to their impact or novelty. It is particularly difficult to accurately recall one's own mood and emotional state at a particular time and place. Retrospective reports of mood state are likely to reflect current mood at the time of

the report itself (Ebner-Priemer & Trull, 2009; Hufford, Shiffman, Paty, & Stone, 2001). Unfortunately, much of the research pertaining to peer associations and influences on adolescent development involves survey-based measures. Because of the above-noted problems, survey methods may not reliability show the ways in which intrapersonal processes such as mood are related to actual social situations and behaviors. By repeatedly sampling contextually situated behaviors and mood states, EMA offers greater statistical power and improved validity over a single retrospective report representing that period of time.

Research on adolescent physical activity is now emerging that utilizes EMA methodology. In a study using EMA with adult females, Wichers and colleagues (2012) found that increases in physical activity were simultaneously associated with increases in positive mood; this increase endured for up to 3 hours after the physical activity. Contrary to the studies cited previously, no effects were found for physical activity and negative mood. Other EMA studies found greater physical activity when youth were with friends, for high school students (Dunton, Whalen, Jamner, & Floro, 2007) and for youth 9–13 years old (Dunton, Intille, Wolch, & Pentz, 2011). These results are promising, but require both replication and extension.

Seasonality is a possible environmental determinant of physical activity that has rarely been examined in real time in longitudinal samples. In studies of children and adolescents using accelerometers to assess activity, there appear to be seasonal differences in activity levels, with the highest activity levels occurring in the summer, a drop-off in the fall to the lowest point in the winter, and increasing again in the spring (Kolle, Steene-Johannessen, Andersen, & Anderssen, 2009; Riddoch et al., 2007; Rowlands, Pilgrim, & Eston, 2009). Declines in physical activity during the winter were also found in a longitudinal study in which adolescents provided retrospective reports of their last 7 days of activity every three months (Bélanger et al., 2009). Seasonal fluctuations of physical activity need to be noted when examining intervention outcome data and such trends may help identify ideal times to intervene.

The purpose of the present study was to investigate situated psychosocial correlates of physical and sedentary activities in early adolescents using EMA methodology. First, we describe the activities reported by early adolescent youth during their free time. Second, we investigate seasonal and gender differences for physical and sedentary activities. Consistent with prior studies, we expected boys to report more physical activity (PA) than girls, rates of PA to decrease over time for both boys and girls, and PA to be less frequent during the winter. We also expected that a decrease in PA would co-occur with an increase in sedentary activity. Third, we used the repeated real-time measurement occasions unique to EMA to examine concurrent within- and between-person correlates of PA and sedentary activity. We expected that PA would be associated with happier mood and with being in the presence of peers and that the strength of associations between PA and happy mood and the presence of peers would be greater for girls than boys. We expected sedentary activity to be associated with sadder moods and with being alone. Given the sparse research, little is known about the routine timing of PA and sedentary activities for youth; therefore, we explored gender and weekday versus weekend differences for sedentary activity. Such information will be valuable in identifying critical time periods and motivating factors for interventions aimed at improving PA in early adolescents.

Method

Study Sample and Design

Participants attended four middle schools (grades 6 to 8) located in the northwestern United States, three in suburban communities and one in a rural community. A school-wide survey was conducted with 6^{th}-8^{th} grade students in the participating middle schools the year prior to recruitment for this study. The 6^{th} grade student data were utilized for selecting the sample of 7^{th} grade students invited to participate in this EMA study. Half of the sample was selected for higher risk behaviors (deviant peer affiliation, antisocial behavior, and tobacco and substance use) based on the survey data and the other half were randomly selected. This sample was stratified by gender. Eligible students were proficient in English and enrolled as a seventh grade student in one of the participating schools. Of 117 total students selected and eligible to participate, 82 (70%) consented to participate; 42 girls and 40 boys. The ethnic/racial composition of the sample was 59% Caucasian, 16% Hispanic/Latino, 5% American Indian, 2% Asian, 1% African American, 1% Hawaiian/Pacific Islander, 9% mixed race/ethnicity, and 7% unknown.

Participants completed four EMA assessment periods in the fall, winter, and spring of seventh grade, and in fall of eighth grade, using a handheld electronic device (iPod Touch®). Each EMA assessment period was one week long and included 27 randomly presented measurement occasions. Delivery and training students in using the EMA device occurred at the participating students' school. Each school had at least two assessment weeks scheduled per season to facilitate data collection. Students who missed the scheduled school assessment weeks could do a "make-up" week within each seasonal time frame. Data were collected from November 2009 to February 2011. Seasons were divided into assessment windows of 10–14 weeks, with longer periods to accommodate school breaks: the Fall assessments occurred from November–January, Winter assessments were from February–March, and Spring assessments were from April–mid-June.

Students were prompted during nonschool hours only, three times Monday through Thursday (from 3:30 to 9:30 p.m.), four times on Friday (from 3:30 to 11 p.m.), six times on Saturday (11:30 a.m. to 11 p.m.), and five times on Sunday (11:30 a.m. to 9:30 p.m.). We selected a 7-day measurement period to accurately capture the rhythms of participants' free time activities across a full week, since many activities for youth follow a weekly schedule and leisure-time activities are likely to differ from weekdays to weekends (e.g., Biddle, Gorely, Marshall, & Cameron, 2009; Kolle et al., 2009). Measurement occasions were randomized within 90–120 minute blocks and were at least 30 minutes apart. Students had to respond within 8 minutes after the first prompt to answer the EMA questions. Each EMA measurement occasion was time stamped, identifying the date and time of day. Students received monetary incentives to participate. Each survey took between 2 and 5 minutes to complete.

Measures

EMA measures relevant to this investigation are provided below. Details regarding the EMA protocol are reported in Rusby, Westling, Crowley, and Light (2012).

Activities—Using the EMA devices, students were asked about activities or behaviors they or other youth present were doing, including physical activities (e.g., sports, hiking, or bicycling), academic activities (homework or reading), and small screen activities (being on the computer, watching television, or playing video games). Students could select multiple activities if applicable. Similar to procedures used by Williams and Mummery (2011), sedentary activities were measured by engagement in small screen recreation (SSR) such as

watching television, playing video games, or computer use, and excluding time engaging in academic activities such as homework or reading. Each activity at each assessment time point was coded dichotomously, with 0 = did not participate in the activity and 1 = participated in the activity.

Moods—Using a 1–9 point scale (*not at all* to *very much*), participants reported on their current mood states (e.g., How happy are you right now? How sad are you right now?). Similar EMA mood state measures have been validated with middle school youth (Mermelstein, Hedeker, Flay, & Shiffman, 2002; Turner, Mermelstein, & Flay, 2004).

Peers Present—Participants were asked how many other youth they were with and if these youth were in elementary, middle, or high school. This measure captured whether each activity was done alone or with one's peers. We defined a *peer* as another middle school-age youth. Peer presence was dichotomous, with 0 = without peer and 1 = with peer.

Weekend—The date and time of each completed measurement occasion was recorded with a programmed time stamp. A dichotomous measure was taken to indicate a completed measurement occasion during the weekend (any time on Saturday or Sunday) or a weekday (any time on Monday through Friday, with 1 = weekend and 0 = weekday.

Participation Rates

Participation was stable throughout the study with 95–98% of youth participating at each assessment period. Eighty-nine percent of the sample participated in all four assessment periods, with 95% participating in the fall seventh grade assessment period, 98% in winter, 95% in spring, and 98% in the eighth grade assessment. Participants rarely chose to skip a question on the assessment; thus, there was less than 1% missing data. On average participants completed 75 measurement occasions out of 108 possible, with 95% of participants completing between 70 and 80 of the measurement occasions. Missing data of assessment occasions were normally distributed and did not differ by gender. Altogether, 6,145 measurement occasions were collected from the 82 participants over the course of the study.

Analytic Procedures

To get a broad sense of basic patterns of adolescent free time activities, we combined the EMA measurement occasions for each assessment period into a single average score per participant utilizing all data available. For dichotomous items (e.g., presence/absence of peers), the mean is simply the proportion of measurement occasions scored as a 1. Bivariate Pearson product-moment correlations were used to measure the strength of association between the proportion of sessions reporting physical and sedentary activity.

Using the aggregated data, a repeated measures ANOVA with post hoc comparisons was conducted to identify differences by gender and season for each outcome; PA and SSR. For the omnibus tests listwise deletion was employed, resulting in a total of 72 participants (82%) with data from all four assessment periods.

We then took a person-centered approach to examine predictors of PA and SSR, using hierarchical generalized linear models (HGLMs) with measurement occasions nested within participants. This approach uses disaggregated data and fully leverages the EMA measurements by locating covarying activities and their predictors in the same situational contexts. As a preliminary step, we evaluated 3-level unconditional models (observations within student within school), and determined that there was no significant school-level clustering (intraclass correlations were less than .01 for both PA and SSR); thus, nesting by

school could be ignored. Data from all four assessments were used in the HGLM analyses, providing a total of up to 108 measurement occasions per individual. For PA, within-individual predictors included happy mood, presence of peers, and weekday/weekend. Similarly for SSR, within-individual predictors were sad mood, presence of peers, and weekday/weekend. For both models, the between individual factor was gender. These models were estimated in HLM v. 6 (Raudenbush, Bryk, Cheong, & Congdon, 2004) with restricted maximum likelihood.

The modeling was done in steps from fully unconditional to conditional. First, fully unconditional models with no predictors were run to estimate sample PA and SSR and the proportion of variance distributed across participants and measurement occasions. Second, conditional level-1 models were run that included characteristics of the measurement occasion (mood, presence of peers, and weekday/weekend) as predictors of PA and SSR. Third, gender was added to identify gender differences in the strength of associations between the measurement characteristics and PA or SSR. Mood was person-centered across the measurement occasions, in keeping with our interest in person-level predictors. This approach allowed us to relate situational activity to individual mood, "standardized" by the individual's typical (average) mood state. At each step, the residual plots were explored to ensure that assumptions of linearity and constant variance for level-2 were met.

Results

Activities of Middle School Youth

The most frequent activity during free time was SSR. In the fall of seventh grade, SSR was reported for 40% of the measurement occasions, whereas youth were engaged in PA and in academic activities 14% and 15% of the measurement occasions, respectively. Eating was the fourth most frequent activity at 12%. Figure 1 illustrates the distribution of activities for seventh grade youth during the fall assessment. Table 1 provides means and standard deviations for each assessment period by gender for the proportion of measurement occasions engaged in activities (PA, SSR, and academics), the proportion of peer presence, and the average happy and sad mood ratings.

Significant variation in PA proportions across the four assessment periods were found, $F(3,213) = 6.56$, $p = .001$. Boys were more physically active than girls, $F(1,71) = 6.35$, $p = .014$, and season-specific gender differences were found in the fall, $t(75) = 2.03$, $p = .046$, and winter, $t(78) = 3.88$, $p < .001$, of seventh grade (see Figure 2). Boys had a significant drop in the proportion of PA in the fall of eighth grade compared to the average of seventh grade reports, $t(38) = -3.41$, $p = .002$, whereas girls increased PA during the spring, $t(38) = 3.72$, $p = .001$.

There was significant seasonal variation in SSR, $F(3,216) = 4.96$, $p = .002$. For both boys and girls, engagement in SSR was higher in the fall of eighth grade compared to the average of seventh grade reports, $t(73) = 3.63$, $p = .001$. Differences between boys' and girls' engagement in SSR was not significant (see Figure 3).

Overall, engagement in PA was negatively associated with engagement in SSR (see Table 2). Significant but relatively weak negative associations between PA and SSR were found during the fall and spring of seventh grade only.

Psychosocial Correlates of Physical Activity and Small Screen Recreation

In the multilevel models showing correlates of PA and SSR, measurement occasions are nested within individuals. The fixed effects show within-participant effects and cross-level

interactions (gender interactions with each independent variable). The random effects show the amount of variance of the dependent variable that is yet to be explained.

The results of the model investigating correlates of PA are shown in Table 3. There was considerably more variation in PA within individuals on different measurement occasions (82%) than between individuals (18%). Boys were more likely to report PA than girls (γ_{01} = 1.03, p = .002). Middle school youth were more likely report PA with peers than when alone (γ_{10} = 1.67, p <.001) and PA was also associated with happier mood (γ_{20} = 0.10, p = .026). PA rates did not differ on weekdays versus weekends (γ_{30} = 0.01, p = .975). Gender did not influence the associations between PA and peer presence (γ_{11} = −0.82, p = .059), happier mood (γ_{21} = −0.05, p = .352), and weekend (γ_{31} = 0.30, p = .242). A significant amount of variance of PA remains to be explained after accounting for the hypothesized individual-level variables and gender interactions.

Table 4 shows SSR models. Similar to findings of PA, the variation in SSR occurred over time within individual (83%), with only 17% between individuals. Girls were just as likely as boys to report SSR (γ_{01} = .23, p = .384). Middle school youth reported more SSR when alone than with peers (γ_{10} = −0.49, p = .017). No associations were detected for SSR and sad mood (γ_{20} = −0.01, p = .782). In post hoc analysis we explored the association between SSR and happy mood (expecting less happy mood when engaged in SSR), yet these associations were also not significant (γ_{30} = 0.12, p = .317). SSR rates did not vary by weekday versus weekend (γ_{01} = 12, p = .317). Further, gender did not influence the associations between SSR and presence of peers (γ_{11} = −0.11, p = .682), sadder mood (γ_{21} = −0.04, p = .260), and weekend (γ_{31} = −0.12, p = .494). A significant amount of variance of SSR remains to be explained after accounting for the hypothesized individual-level variables and gender interactions.

Discussion

This study has used EMA methodology to examine situation-specific, within-person correlates of physical and sedentary activities. EMA measurement allowed us to obtain concurrent “in the moment” relations between the presence of peers, moods, and activities in an adolescent sample. In particular, measuring peer presence during PA and SSR with this methodology is unique. This study also joins a handful of extant publications using EMA to examine correlates of such activities with mood, overcoming the reliability problems with retrospective reports of mood. The moment-to-moment measurement of peer presence, moods, and behaviors offers a more nuanced understanding of factors that may impact engagement in PA or SSR, and thus contribute to the development of interventions designed to promote physical activity in youth, which have so far been largely ineffective (Metcalf, Henley, & Wilkin, 2012).

Our results are consistent with prior research (Guthold et al., 2010; Robbins et al., 2009; Sallis et al., 2000; Sallis, 2000) showing that early adolescent boys engage in more PA than girls, and that boys appear to have a steeper decline in PA compared to girls starting around age 13 (Kahn et al., 2008). Since no studies (ours or others) have yet identified the reason for this decline, we hypothesized that it might be due to competing activities, such as increases in SSR. However, we found no gender differences in sedentary activities such as SSR, which was the most prevalent free time activity. SSR occurred more than twice as often as any of the next three most frequent activities (academics, PA, and eating) and it increased over time for both boys and girls. The negative correlation between PA and SSR shows that these activities are not completely independent, but the weak relationship suggests that most youth engage in both PA and SSR.

Similar to prior research (Gordon-Larsen et al., 2004; Guthold et al., 2010; Sallis et al., 2000) we found decreasing PA over time. In our sample we found gender-specific seasonal effects; boys reported a significant drop in PA from the first assessment in seventh grade to the eighth grade assessment, whereas girls reported a significant increase in PA during the spring. Perhaps more sports, such as track and field, softball, or swimming were available to girls during the spring compared to other seasons. Replication is needed to see if these findings generalize to other samples. Nevertheless, further exploration of localized trends can inform efforts to increase PA in adolescent girls by exploring what is happening in the communities in spring that is absent during the other seasons. We are not aware of events in the study communities that could have explained this finding.

We found no gender differences in the frequency of reported SSR, a sedentary activity. Gender differences in other types of sedentary activities, such as reading or sitting around talking, have not been examined. As expected, increases in SSR were found over time. There was a significant jump in SSR from the average of the three seventh grade assessments to the eighth grade assessment for both boys and girls. It appears that SSR was not impacted by seasonal changes.

Aligning with research that has shown the potential of social support for engagement in PA for older adolescents (Dunton et al., 2007) and younger youth (Dunton et al., 2011), we also found that PA was more likely to occur with peers rather than alone for middle school-age youth. Although we expected PA and peer presence to be more strongly associated for girls than for boys, this was not the case. PA tended to be a social activity for both boys and girls. In contrast, SSR tended to be a solitary activity. The association between SSR and absence of peers did not differ by gender.

Our results concur with another EMA study showing an association between PA and happiness (Wichers et al., 2012). This finding raises the question of whether PA might be a motivating factor in itself— one tends to be happier when engaged in PA, which makes it more likely that one will engage in PA in the future. The research is mixed regarding gender differences in associations of mood and PA. Our results indicate that the strength in the association between happier mood and PA does not differ for both boys and girls. Previous studies have also found associations between depressed mood with less PA and more sedentary activities (Motl et al., 2004; Sallis et al., 2000; Sund et al., 2011). In contrast, we did not find an association between sad mood and SSR as expected. It is possible that the entertainment value specific to SSR may have a protective effect that is not captured by broader measures of sedentary activity. Youth may also feel engaged and included in peer activities via SSR if they are using social networking sites or playing interactive video games with others.

We also explored whether there were routine effects in the timing of physical activities and SSR for youth. We found that PA and SSR were not differentially likely to occur on the weekday or weekend.

Study Limitations

Although this study had many strengths, there were also a few limitations. This study took place in four rural and suburban communities in the Pacific Northwest; therefore, the population under study lacks the ethnic and racial diversity found in more urban populations. The sample, specifically, is limited in the representation of African American and Asian youth.

Another possible limitation is that participant self-monitoring via EMAs changed behavior, as in many physical activity and weight loss intervention programs consistent self-

monitoring predicts success (e.g., Boutelle & Kirschenbaum, 1998; Conroy et al., 2011; Krukowski et al., 2012). However, in nonintervention studies such as this one, the effects of EMA on behaviors have not been significant (e.g., Hufford et al., 2002). In addition, participants selected behaviors they were engaged in from a list of options; neither physical activity nor sedentary activities were labeled as such or emphasized.

Additionally, we did not assess PA and SSR during all seasons. First, because this study was related to a school-based study, the delivery of the data collection devices occurred at participants' schools, and therefore summer data collection did not occur. Second, fall assessments included part of the winter (January), due to school winter breaks. However, the weather in northwestern U.S. is similar during these three months and in post hoc analysis we found no differences in PA in November–December compared to January. Ideally, a study on seasonal effects would more accurately reflect each of the four seasons.

A final limitation is that our measure of PA did not differentiate between moderate and vigorous physical activity. This differentiation has been made in intervention studies aimed at decreasing obesity in children. For example, Davis and colleagues (2007) compared outcomes for a group of overweight elementary school children who received an intervention involving vigorous PA to a group who received moderate PA; the children in the vigorous exercise group showed improvements in executive function, whereas the children in the moderate exercise group did not. This distinction may also be important for adolescent outcomes.

Implications for Practice

Our findings showing that PA is a social phenomenon for middle school youth strongly suggest that interventions involving PA with peers may be more effective than those involving solitary activities. These findings also imply that a peer-centered approach for increasing PA may work well for both boys and girls.

To date, PA interventions have mainly focused on adolescent girls (Dishman et al., 2009; Lytle et al., 2009). We agree that focusing on girls is important. Our study provides supporting evidence that during early adolescence, girls are less physically active than boys. However, the decline in PA for boys suggests that it is important to target interventions for both boys and girls at this age.

Efforts to increase PA are expected to have long-ranging health benefits (Andersen et al., 1998; Institute of Medicine, 2012; Patrick et al., 2004). It is possible that efforts to increase PA in youth would also improve psychological well-being and decrease negative behavior patterns (e.g., law breaking, substance abuse); however, that research has yet to occur. It is our hope that this study has provided some important insights for such efforts.

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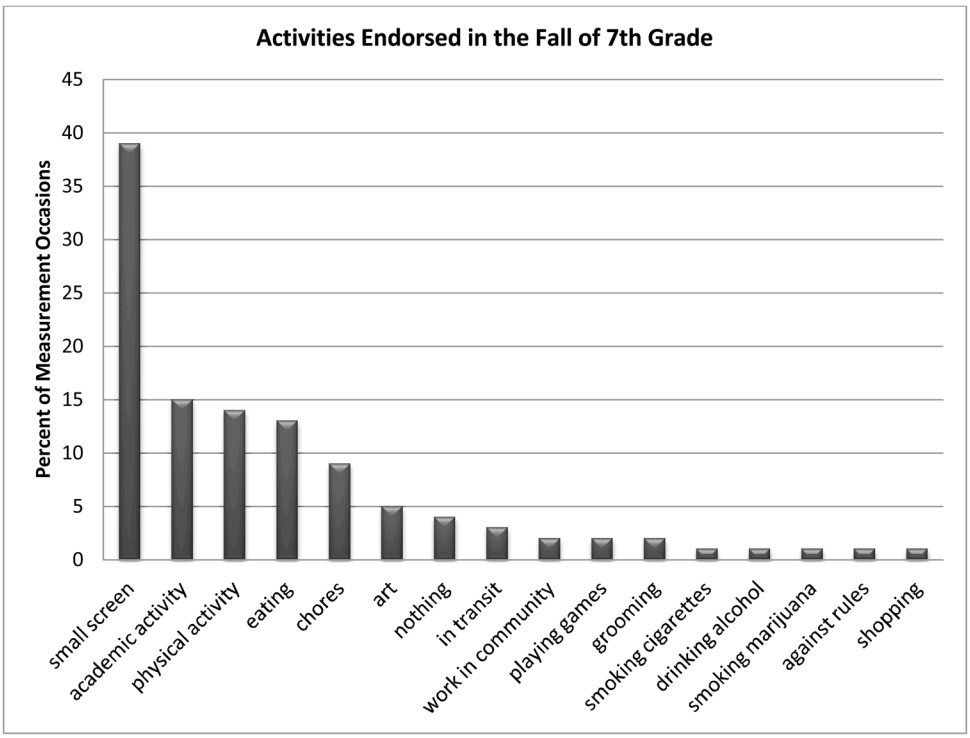

Figure 1.
Free Time Activities of Adolescents

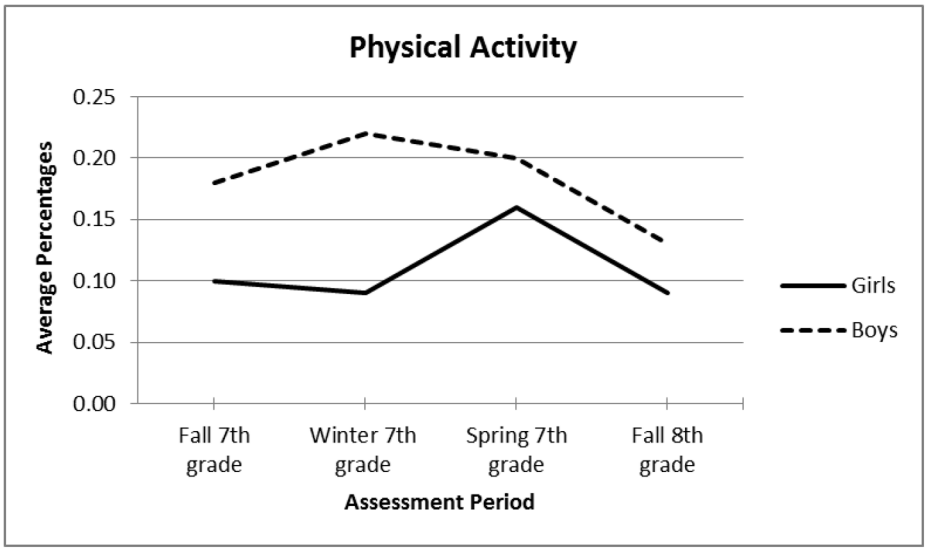

Figure 2.
Physical Activity of Boys and Girls Over Time

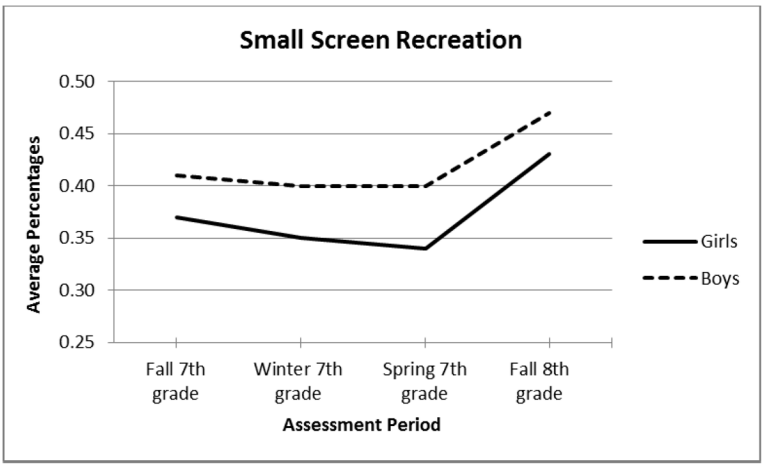

Figure 3.
Small Screen Recreation of Adolescent Boys and Girls Over Time

Table 1

Means and Standard Deviations of Activities, Moods, and Peer Presence by Wave and Gender

	Grade 7 Fall				Grade 7 Winter				Grade 7 Spring				Grade 8 Fall			
	Boy (*N* = 40)		Girl (*N* = 38)		Boy (*N* = 40)		Girl (*N* = 40)		Boy (*N* = 39)		Girl (*N* = 39)		Boy (*N* = 39)		Girl (*N* = 41)	
Measures	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***
Activity[a]																
Physical Activities	0.18	0.20	0.10	0.11	0.22	0.17	0.09	0.12	0.20	0.19	0.16	0.16	0.13	0.18	0.09	0.10
Academic Activities	0.14	0.20	0.16	0.14	0.20	0.24	0.20	0.21	0.18	0.26	0.20	0.20	0.14	0.21	0.16	0.15
Small Screen Recreation	0.41	0.26	0.37	0.20	0.40	0.24	0.35	0.20	0.40	0.24	0.34	0.20	0.47	0.29	0.43	0.18
Peers Present[a]	0.27	0.27	0.25	0.25	0.27	0.25	0.27	0.25	0.27	0.26	0.22	0.23	0.24	0.27	0.25	0.23
Mood[b]																
Happy	6.80	1.47	6.50	1.73	6.38	1.77	6.01	2.05	6.05	1.87	6.18	1.80	5.84	1.93	5.92	1.65
Sad	2.27	1.23	3.12	2.16	2.53	1.89	2.97	1.89	2.11	1.36	2.97	2.09	2.53	2.05	2.85	2.02

[a] Proportion of occasions the activity or presence of peers occurred, ranging from 0–1.

[b] On a scale of 1–9, with 1 indicating low and 9 high on that mood.

Table 2

Correlations between the Proportion of Physical Activity (PA) and Small Screen Recreation (SSR) Endorsements by Wave

	Wave 1	Wave 2	Wave 3	Wave 4	Overall
Correlation of PA and SSR proportions	−.33**	−.11	−.28*	−.20	−.24*
N of Participants	77	80	78	79	82

* $p < .05$.

** $p < .001$.

Table 3

Effects of Peer Presence, Mood, Weekend, and Gender on the Odds of Participating in Physical Activity (a Two-Level Analysis of Physical Activity)

Fixed Effect[a]	Parameter	Coefficient (Log Odds)	Odds Ratio	*SE*	*t*-ratio	*p*-value
PA Intercept	γ_{00}	−3.19	0.04 [0.03–0.06]	0.22	−14.26	< .001
PA x Gender	γ_{01}	1.03	2.79 [1.49–5.25]	0.32	3.24	.002
Presence of Peers	γ_{10}	1.67	5.32 [2.75–10.30]	0.33	5.03	< .001
Peers x Gender	γ_{11}	−0.82	0.44 [0.19–1.03]	0.43	−1.92	.059
Happy Mood	γ_{20}	0.10	1.11 [1.01–1.22]	0.05	7.27	.026
Happy x Gender	γ_{21}	−0.05	0.95 [0.86–1.06]	0.05	−0.94	.352
Weekend	γ_{30}	0.01	0.99 [0.67–1.47]	0.20	−0.03	.975
Weekend x Gender	γ_{31}	0.30	1.35 [0.81–2.24]	0.25	1.18	.242

Random Effect[b]	Parameter	Standard Deviation	Variance Component	*df*	χ^2	*p*-value
Odds of PA Intercept	r_0	0.90	0.81	77	342.43	< .001
Effect of peers	r_1	1.24	1.53	77	234.68	< .001
Effect of happy	r_2	0.11	0.01	77	116.57	.003
Effect of weekend	r_3	0.58	0.33	77	131.91	< .001

Note. *N* of measurement occasions = 6,115; *N* of participants = 82. 95% confidence intervals are in brackets. Gender is coded with girl = 0 and boy = 1.

[a] Fixed effects estimates represent within-participant and cross-level interactions and are based on the Laplace estimation model.

[b] Random effects estimates represent the amount of unexplained variance and are based on the unit-specific model with robust standard errors.

Table 4

Effects of Peer Presence, Mood, Weekend, and Gender on the Odds of Participating in Small Screen Recreation (a Two-Level Analysis of SSR)

Fixed Effect[a]	Parameter	Coefficient (Log Odds)	Odds Ratio	*SE*	*t*-ratio	*p*-value
SSR Intercept	γ_{00}	−0.53	0.59 [0.48–0.74]	0.21	−2.51	.015
SSR x Gender	γ_{01}	0.23	1.26 [0.84–1.89]	0.26	0.88	.384
Presence of Peers	γ_{10}	−0.49	0.61 [0.47–0.86]	0.20	−2.43	.017
Peers x Gender	γ_{11}	−0.11	0.89 [0.57–1.42]	0.28	−0.41	.682
Sad Mood	γ_{20}	−0.01	0.99 [0.95–1.04]	0.03	−0.28	.782
Sad x Gender	γ_{21}	−0.04	0.96 [0.90–1.02]	0.04	−1.14	.260
Weekend	γ_{30}	0.12	1.12 [0.91–1.39]	0.11	1.01	.317
Weekend x Gender	γ_{31}	−0.12	0.89 [0.67–1.20]	0.17	−0.69	.494

Random Effect[b]	Parameter	Standard Deviation	Variance Component	*df*	χ^2	*p*-value
Odds of SSR Intercept	r_0	0.83	0.69	77	421.30	< .001
Effect of peers	r_1	0.71	0.51	77	157.94	< .001
Effect of sad	r_2	0.06	0.00	77	84.93	.251
Effect of weekend	r_3	0.39	0.15	77	115.40	.003

Note. *N* of measurement occasions = 6,115; *N* of participants = 82. 95% confidence intervals are in brackets. Gender is coded with girl = 0 and boy = 1.

[a] Fixed effects estimates represent within-participant and cross-level interactions and are based on the Laplace estimation model.

[b] Random effects estimates represent the amount of unexplained variance and are based on the unit-specific model with robust standard errors.