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# Physical Activity and Screen Time in Adolescents and Their Friends

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## Abstract

**Background—**Little is known about the actual physical activity and screen time behaviors of an adolescent's friends relative to the individual's behavior.

**Purpose—**To determine the associations between an adolescent's physical activity and screen time and his/her nominated friends' physical activity and screen time.

**Methods—**Data were obtained from EAT 2010 (Eating and Activity Among Teens), a large cross-sectional study ($n$=2126) conducted in 20 middle schools and high schools in Minneapolis/St. Paul MN during the 2009–2010 academic year and analyzed during 2011. Each participant nominated up to six friends from a school roster, and data from those friends were obtained as part of the school-based data collection procedures. Physical activity and screen time were assessed with previously used and validated questionnaires. Generalized estimating equation models, stratified by gender, were used to assess associations between adolescents' physical activity and screen time and their friends' physical activity and screen time.

**Results—**Physical activity for female adolescents was associated with their male and female friends' physical activity, including their male and female best friends (all $p<0.05$). Males' physical activity was associated with their female friends' physical activity ($p<0.03$). Females' screen time was associated with their male and female friends' screen time ($p\leq0.03$), but not with that of their best friends. Males' screen time was associated with only their female friends' screen time ($p$=0.04).

**Conclusions—**The consistent association between female adolescents' physical activity and their friends' physical activity indicates a need to include peer effects on adolescent female physical activity in future intervention work.



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Meg Bruening was employed at the University of Minnesota when this research was completed.

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## Introduction

Physical activity levels suffer a marked decline during adolescence, especially for girls, with the most dramatic decline occurring between ages 15 and 18 years.[1] Using longitudinal data from Project EAT (Eating and Activity among Teens), Nelson et al.[2] reported significant declines (especially for girls/women) in moderate-to-vigorous physical activity (MVPA) in adolescents who were followed from age 16 years to age 20 years. This decline in MVPA is an important and timely issue, given currently low levels of adequate physical activity in youth,[3] high levels of screen time,[4] and recent increases in pediatric obesity and related chronic diseases.[5–8] There remains uncertainty, however, regarding the social factors associated with adolescent physical activity and screen time.

The social influences on adolescent physical activity have primarily been assessed by adolescents' perception of the social support they receive for being physically active from friends, family, and other adults who are important in their lives. Generally, perceived social support for physical activity is positively associated with higher physical activity in adolescents.[9–11] However, some studies have found no association[12,13] or observed that the association is stronger for girls than boys.[14] Although social support tells us about the supportive behaviors of friends, it does not tell us how active or inactive the friends are.

Even less is understood about the correlates and/or determinants of screen time or sedentary behavior in youth; only parent support for reduced screen time has been associated with child, but not adolescent, physical activity.[15–17] A deeper understanding of social factors associated with adolescent physical activity and screen time behavior is warranted for several reasons. First, individuals become more autonomous from their parents and rely more heavily on behavioral cues from friends during adolescence.[18,19] Second, physical activity significantly declines during adolescence. Lastly, while peer social support for physical activity has been observed in previous studies, there is very limited research on the actual associations between peer and adolescent physical activity and screen time.

Using nominated-friend data represents a new approach to studying adolescents' social environments related to physical activity and screen time. Related to physical activity and screen time, a small number of studies using the National Longitudinal Study of Adolescent Health (Add Health) support the social causation spread of obesity in adolescents.[20–22] The results, however, are not conclusive.[23,24] Even if obesity does indeed spread, to some extent, through social causation, researchers and health practitioners still need to understand the behaviors that directly contribute to that excess weight gain (e.g., physical activity and screen time for the current study). Therefore, focusing attention on the behavioral precursors of excess weight gain will provide more applicable information that can be used to develop obesity prevention efforts.

Studies examining other behaviors such as substance use[18,25–27] have suggested a pattern of social causation but, to the best of our knowledge, very limited research has been done with adolescent physical activity and screen time. There are only a limited number of studies that specifically investigated adolescent peer associations[28–32] or influences[33] on physical activity. Cross-sectional studies by Ali et al.[28] using data from the Add Health study, and by de la Haye et al.[29] using data from 8$^{th}$- and 9$^{th}$-grade Australian students, both observed associations between individual and peer physical activity.[28,29] Associations between individual and peer "other" screen time (not including TV/movies) were also reported.[29] The association between individual and friend physical activity and screen time is especially relevant since time spent being physically active or in front of a screen can often involve social interactions with friends (e.g., sports teams, exercise partner, watching movies, or playing video games).

The Ali et al. study[28] used a large nationally representative sample, but the analyses were not stratified by gender, limiting the interpretation of the results for future intervention development. The data in de la Haye et al.[29] were stratified, similar findings were observed across gender. Still, the sample was a relatively small sample (N= 378) from Australia and did not include any older adolescents. A recent systematic review[34] presents more-detailed information on research in this area.

The purpose of this study was to examine whether friends' physical activity and screen time was related to an individual adolescent's (the "ego's") physical activity and screen time by using data provided by nominated friends. The authors hypothesized that associations between ego and friend physical activity and screen time behavior would be significant between egos and friends of the same gender. In addition, it was hypothesized that, due to increases in autonomy and greater reliance on behavioral cues from peers,[18,19] associations between ego and friend behaviors would be stronger for high school versus middle school students.

## Methods

### Sample

The EAT-2010 study was designed to examine dietary intake, physical activity, weight control behaviors, weight status, and factors associated with these outcomes in adolescents. Participants were adolescents (mean age 14.4 ± 2.0 years) recruited from 20 public schools in Minneapolis and St. Paul MN. Six schools were traditional middle schools (6th–8th grade), eight were traditional high schools (9th–12th grade), three were kindergarten (K)–8th grade, one was K–12th grade, one was 6th–10th grade, and one was 7th–12th grade.

Trained research staff administered surveys and measured adolescents' height and weight during selected health, physical education, and science classes during the 2009–2010 academic year with analyses carried out in 2010–2011. All study procedures were approved by the University of Minnesota's IRB Human Subjects Committee and by the research boards of the participating school districts. Adolescents provided assent unless their parent/guardian returned a signed consent form indicating their refusal to have their child participate. Among adolescents who were in the selected classes on the days of survey administration, 96.3% assented to participate.

Of 2793 youth, a subset of adolescents ($n$=2126) had at least one friend included in the analytic sample. Participants nominated an average of 5.2±1.3 (of a possible six) friends. An average of 2.1±1.7 of these friends were included in the EAT-2010 sample and provided usable data on their own surveys. Overall, 76% of the original sample of adolescents had at least one friend who completed the EAT-2010 survey.

Approximately half (46%) of the sample was male and 52% were from middle schools (Table 1). The sample was racially and ethnically diverse; 80% of the adolescents were from ethnic minorities. The majority of students (87%) were from low-to-middle-income families. Slightly more than 40% of the sample was considered overweight or obese. Female adolescents were slightly younger ($p$=0.03), more racially/ethnically diverse ($p$=0.01), from lower-SES backgrounds, and less likely to be classified as overweight ($p$=0.05) than male adolescents.

### Measures

**Friend nominations—**An assessment of friend behaviors through the collection of friendship nominations was included as a survey instrument, as has been done in previous studies.[22,37–39] Lists of all students by grade level were obtained in advance of data

collection from each school. Rosters were compiled for each school and a unique four-digit network identification (ID) number was created for each enrolled student in the school.

After data collection, participants were provided with the rosters, which were alphabetized and separated by grade level. Participants found, recorded, and ranked the IDs of their three closest female friends and three closest male friends from the roster. Students were permitted to nominate fewer than six friends, as well as to nominate friends outside of the school with a generic code (9999). Data provided by each nominated friend on his or her own survey was linked by ID number back to the original nominating friend (the "ego"), allowing for the creation of friend predictors unique to the ego participant.

Because students were sampled from required classes, inclusion in the sample is presumed to be random. Any friend that was nominated is also expected to be a random sample of any individual's nominated friends. A sensitivity analysis was conducted, and results indicated that using all participants with at least one friend provided substantively similar results to using more-stringent inclusion criteria (e.g., a majority of nominated friends).

**Godin-Shephard Physical Activity Recall—**The Godin-Shephard (G-S) recall asks the participant to recall the amount of time in a "usual" week he/she spent in "strenuous exercise (heart beats rapidly)," "moderate exercise (not exhausting)," and "mild exercise (little effort)." Examples for each intensity level were provided and included "biking fast, aerobics, jogging, basketball, swimming laps, soccer, rollerblading" for strenuous, "walking quickly, easy bicycling, volleyball, skiing, dancing, skateboarding, snowboarding" for moderate, and "walking slowly, bowling, golf, fishing, snowmobiling" for mild exercise.

The G-S recall has been previously validated in adolescent and adult populations using several different criterion measures. These include Caltrac accelerometer ($r$ =0.32 to 0.45)[40,41], aerobic fitness ($r$ = 0.38 to 0.56)[40,42], and other physical activity questionnaires ($r$ = 0.36 to 0.61)[41–44]; and a modified version has been used in previous waves of Project EAT.[2,45,46]

The six response options ranged from "none" to "6+ hours a week." The midpoint of each response option was used to calculate the hours per week spent in MVPA (sum of strenuous and moderate). One-week test–retest reliability of the G-S recall in a separate sample of 66 young adults was $r$ =0.85.

**Screen time—**Participants were asked, *In your free time on an average weekday (Monday–Friday), how many hours do you spend doing the following activities?* Activities included, *Watching TV/DVDs/videos*, *Using a computer (not for homework)*, and *Xbox/Play-Station/other electronic games that you play when sitting*. The same questions were asked for "an average weekend day (Saturday and Sunday)". The seven response options ranged from "0 hr" to "5+ hr". Test–retest reliabilities for weekday and weekend individual items were, respectively: $r$ = 0.63 and 0.64 for TV viewing; $r$ =0.76 and 0.77 for computer use; and $r$ =0.72 and 0.84 for electronic games. The weighted mean was calculated based on responses to these six questions to obtain the weekly hours spent on screen time.[46]

**Body mass index—**To control for the possible confounding effect of excess weight on physical activity and screen time behavior, each participant's BMI was obtained from measured height to the nearest 0.5 cm and weight to the nearest 0.1 kg by trained research staff. BMI percentiles were derived from the CDC Growth Charts.[35] Participants below the 85th percentile were considered normal weight, ≥85$^{th}$ percentile were categorized as overweight, and those above the 95th percentile as obese.

**Demographics—**Students reported their birth date (used to calculate age, in years) and their race/ethnicity. The students' SES was calculated using an algorithm that has been used in previous waves of Project EAT in which the primary determinant of SES is parental educational level.[36]

### Data Analysis

Descriptive summaries of demographics, weight status, MVPA and screen time were calculated separately by gender for specific subsamples with either male or female friend data available. To examine the association between MVPA and screen time of the ego with his/her friends' behaviors, gender-specific summaries of available friends' data were computed. Male and female friends' predictors were computed by taking the mean of the available nominated-friend data (between one and three friends for each gender). "Best" male and female friend predictors were taken to be the observed values of the first-ranked nominated friend.

Linear regression models of ego behaviors (MVPA or screen time) were fit separately for each gender-specific friends' summary predictor variable (i.e., male friends, female friends, male best friend, female best friend). A dummy variable indicating each school was included as a fixed effect in the regression models to account for clustering of individuals within schools, and all models additionally controlled for the ego's age, race/ethnicity, SES, BMI, and number of gender-specific friends available. The results were similar between the unadjusted and the adjusted; therefore, only results from the adjusted models are presented.

An evaluation was made of the possibility of differential effects of peers by school level (middle school versus high school) by including and testing an interaction between school level and each of the friends' summary predictor variables (separately) in the linear regression models where school was included as a random effect for the purpose of testing the school-level covariate interaction. All analyses were stratified by the gender of the ego. All analyses were performed in SAS 9.2.

## Results

Male adolescents reported more hours per week of MVPA than female adolescents (6.83 ± 4.84 vs 4.98 ± 4.40, $p<0.001$), but they also reported more hours per week of screen time (45.15 ± 28.85 vs 36.51 ± 23.92, $p<0.001$). MVPA among male adolescents was associated with MVPA of female friends (Table 2). On average, for every additional hour per week of female friend MVPA, there were approximately six additional minutes of MVPA per week for male adolescents. MVPA in female adolescents was associated with the MVPA of male and female friends and with her female best friend. Every additional hour of friend MVPA was associated with approximately 5–8 additional minutes of MVPA per week for female adolescents.

The screen time of female adolescents was associated with only male friends' screen time. For every additional hour of male friends' screen time, there were approximately 6 additional minutes of screen time per week for female adolescents. The screen time of male adolescents was not associated with any of their friends' screen time (Table 2).

There were no school-level interaction effects for the majority of tests run (12 of 16 interaction tests). However, all four of the interactions found indicate that there was only an association between the ego and nominated friends for the high school students, not the middle school students. These interactions included: the MVPA of adolescent males and their female friends' MVPA ($\beta=0.217$, $p< 0.001$); the MVPA of male adolescents and their best female friend's MVPA ($\beta=0.204$, $p=0.036$); the MVPA of female adolescents and their

best female friend's MVPA (β=0.217, *p*=0.032), and the screen time of male adolescents and their best female friend's screen time (β=0.246, *p*=0.021).

For all three interaction for MVPA, the average regression coefficient was β=0.213, indicating that, for every additional hour per week of high school friend MVPA, there was approximately 13 additional minutes of MVPA per week for the individual. The coefficient for the screen time interaction indicates that every additional hour of a best female friend's screen time was associated with an additional 15 minutes of screen time per week for high school boys.

## Discussion

Several associations were observed between ego and friend MVPA and screen time, indicating that, to some extent, these behaviors are shared among friends. More associations were found among female adolescents for MVPA than among male adolescents, suggesting the importance of social relationships and social support for MVPA in female adolescents. The current study used the novel technique of ego-centric analysis to obtain data from the adolescents and the friends that they nominated, rather than relying on the subjective reports of each adolescent's perception of their friends' behavior. To our knowledge, this is one of the first studies [28,29,33] to use this technique with the behaviors of physical activity and screen time.

Physical activity of adolescent females, as opposed to males, may be more strongly influenced by friends. These current findings support previous research on correlates of sports participation indicating that girls rate social aspects (e.g., being a member of a team, being with friends) as some of the strongest appeals for their sports participation.[47] Contrary to the hypothesis for the current study, on same-gender associations, male adolescents' MVPA was not associated with male friends' MVPA or best male friend's MVPA. These results suggest that adolescent male MVPA may be more associated with other individual-, school-, and neighborhood-level factors.

Compared to MVPA, less-consistent findings were observed for screen time in the current study. A male adolescent's screen time was not associated with any friends' screen time, although there was a trend for an association with female friends' screen time (*p*=0.084). The interaction with school level (*p*=0.021) indicates that this association holds for high school but not middle school students. In high school boys, for every additional hour of their female friends' screen time, there was an additional 15 minutes of screen time for boys. In contrast, there was an association between a female adolescents' screen time and her male friends' screen time (*p*=0.007), but no school-level interaction was observed. For a female adolescent, the coefficient of 0.094 indicates that for every 1-hour increase in her male friends' screen time, there is a 5.5-minute increase in her screen time per day.

The fact that different results were observed for MVPA versus screen time indicates the presence of various social correlates for each behavior. The current findings support a developing body of literature focused on differentiating the determinants and health effects of physical activity versus sedentary behavior.[48–50] The current findings also support previous research suggesting that sedentary behavior is not merely the mirror image of physical activity behavior, but rather that sedentary behavior is its own behavior with distinct multilevel correlates.[17]

The current study builds on de la Haye et al.'s work with 8$^{th}$- and 9$^{th}$-grade Australian adolescents[29] by using a much larger, diverse population of U.S. youth, including older adolescents. They reported cross-sectional associations between male and female adolescents' organized physical activity and both male and female friends' organized

physical activity, respectively. The current study adds support to these previous findings indicating associations between female MVPA and female friends' MVPA.[51]

Also observed by de la Haye et al.[29] were associations between a female adolescents' s non-TV screen time and her female friends' screen time. No associations, for male or female adolescents, were observed for TV/movie time in that study. In the current study, an association was observed between a female adolescent's screen time and her male friends' screen time. The difference in findings between the two studies may be due to the difference in study design, population studied, analytic methods, or not separating TV/movies from other media for the current study.

Using a large cross-sectional sample from the Add Health data set, Ali et al.[28] observed associations between individuals' and friends' exercising at least three times in the past week and sports participation (both binary variables). There was no analysis by gender in that study. The current study adds to the literature by identifying more-consistent associations between female adolescents' MVPA and friends' MVPA, compared to associations with male adolescents' MVPA. This is consistent with previous research that has shown associations between peer social support and female physical activity.[14,51]

The age group effect (middle school vs high school) for only four associations indicates limited support for the current hypothesis that associations would be stronger for the older high school students versus the younger middle school students. Some previous research, primarily in smoking initiation, supports an age-related increase in peer influence,[18,19] but not all studies have observed such findings,[52] and at least one study showed age-related increases in resistance to peer influences.[53] The current findings may indicate that friend influences on MVPA and screen time may already be established by middle school. Thus, physical activity and screen time intervention efforts that contain a social environment component could be similar for both middle school and high school students.

The current study was cross-sectional, and as such, temporality and causality cannot be established, with several possible explanations for the observations in the current study.[54] First, an adolescent may become friends with others and then alter his/her behavior to match these new friends (social causation). Second, the behavior of friends may change to be similar to the new individual in the friendship network (reverse causality). Third, adolescents with similar physical activity and screen time behaviors at the outset may choose to become friends (social selection). Lastly, adolescents may have similar physical activity levels due to other external variables or become friends for other unidentified reasons that would then influence physical activity and screen time behavior (contextual effects).

Using 1-year longitudinal data from a cohort of N= 378 Australian adolescents, de la Haye et al.[33] observed that individuals became friends with those that performed similar levels of physical activity (social selection) and that the individual also altered his/her behavior to become more like the group (social causation). Additional longitudinal research in this area is needed in larger, more diverse populations and over longer periods of time to more fully understand the role of friends and changing friendships on adolescent physical activity and screen time.

It was not possible, with the current data, to determine if the participants in a given friendship group belonged to the same sports teams or if they viewed the same screen media content. Such detailed data would need to be the focus of more specific research studies, preferably using longitudinal data and more complete friendship network data, to track changes in friendships and behaviors over time.

### Conclusion

Although most correlational studies of adolescent physical activity and screen time rely on perceived support for these behaviors from family and friends, the current study used data collected from nominated friends to better understand how their physical activity and screen time behaviors are associated with the individual's behavior. The large and diverse sample of middle and high school students is reflective of the school populations in the participating school districts. These findings suggest that further research in this area may inform peer-focused interventions to promote physical activity and decrease screen time in adolescents.

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**Table 1**

Sample characteristics for *n*= 2126 adolescents (egos) with at least one friend in the data set

| | **Male (*n*=983)** | **Female (*n*=1143)** | ***p*-value** |
|---|---|---|---|
| **Age** (years) | 14.29±2.01 | 14.11±1.88 | 0.03 |
| **Grade** | | | |
| Middle School (*n*=1114) | 504 (51.3) | 610 (53.4) | 0.34 |
| High School (*n*=1012) | 479 (48.7) | 533 (46.6) | |
| **Ethnicity group** | | | |
| White (*n*=426) | 224 (22.8) | 202 (17.7) | |
| African-American/black (*n*=567) | 260 (26.5) | 307 (26.9) | |
| Latino/Hispanic (*n*=373) | 164 (16.7) | 209 (18.3) | 0.01 |
| Asian American (*n*=409) | 195 (19.8) | 214 (18.7) | |
| Native American (*n*=87) | 40(4.1) | 47 (4.1) | |
| Mixed/Other (*n*=264) | 100 (10.2) | 164 (14.4) | |
| **SES** | | | |
| Missing (*n*=64) | 31 (3.2) | 33 (2.9) | |
| Low (*n*=796) | 322 (32.8) | 474 (41.5) | |
| Low-middle (*n*=450) | 213 (21.7) | 237 (20.7) | <.001 |
| Middle (*n*=361) | 176 (17.9) | 185 (16.2) | |
| Upper-middle (*n*=286) | 145 (14.8) | 141 (12.3) | |
| High (*n*=169) | 96 (9.8) | 73 (6.4) | |
| **Weight Status** | | | |
| Not overweight (*n*=1272) | 566 (57.6) | 706 (61.8) | 0.05 |
| Overweight: BMI ≥85$^{th}$ percentile (*n*=854) | 417 (42.4) | 437 (38.2) | |
| **Mean number of Any friends in the data set** | 2.64±1.50 | 2.62±1.43 | 0.78 |
| **Mean number of Male friends in the data set** | 1.49±0.93 | 1.01±0.94 | <.001 |
| **Mean number of Female friends in the data set** | 1.15±0.99 | 1.61±0.94 | <.001 |

Note: Values are M±SD or *n* (%). Overweight status is based on the CDC's age- and gender-specific BMI curves with overweight defined as ≥85$^{th}$ percentile national.[35] SES was calculated using an algorithm in which the primary determinant is parental educational level. [36]

## Table 2

Estimated change in adolescent's (ego's) physical activity or screen time per week for every 1 hour increase in respective mean for friends

| | Male Friends | Female Friends | Male Best Friend | Female Best Friend |
|---|---|---|---|---|
| **Male Ego** | *n*=838 | *n*=668 | *n*=483 | *n*=389 |
| **Physical Activity** | 0.036 (0.040) | **0.092 (0.047)** | 0.061 (0.046) | 0.029 (0.057) |
| *p*-value | 0.361 | **0.049** * | 0.186 | 0.608 * |
| **Male Ego** | *n*=839 | *n*=667 | *n*=484 | *n*=389 |
| **Screen Time** | −0.006 (0.041) | 0.094 (0.054) | −0.051 (0.046) | 0.065 (0.059) |
| *p*-value | 0.894 | 0.084 * | 0.270 | 0.270 |
| **Female Ego** | *n*=723 | *n*=1007 | *n*=404 | *n*=612 |
| **Physical Activity** | **0.103 (0.038)** | **0.138 (0.037)** | 0.060 (0.045) | **0.077 (0.039)** |
| *p*-value | **0.007** | **0.0002** | 0.183 | **0.051** * |
| **Female Ego** | *n*=725 | *n*=1008 | *n*=402 | *n*=612 |
| **Screen Time** | **0.094 (0.035)** | 0.066 (0.041) | −0.024 (0.043) | 0.006 (0.042) |
| *p*-value | **0.007** | 0.107 | 0.583 | 0.883 |

Note: adjusted for age, SES, race/ethnicity, BMI of ego, and number of friends available. A $\beta = 0.138$ means that for every additional hour per week of female friends' physical activity, there would be a 5.5-minute per week increase in the individual female's (female ego's) physical activity. Boldface indicates significance.

* Significant grade level x friend behavior interaction; there was an association between individual (Ego) and friend physical activity or screen time for high school students but not middle school students ($p \leq 0.036$).