The social context moderates the relationship between neighborhood safety and adolescents' activities

Sarah-Jeanne Salvy a,⁎, Denise M. Feda b, Leonard H. Epstein b, James N. Roemmich c

a University of Alabama at Birmingham, 1720 2nd Ave South, Birmingham, AL 35294, United States
b University at Buffalo, 3435 Main St, Buffalo, NY 14214, United States
c United States Department of Agriculture, Agricultural Research Service, 2420 2nd Ave North, Grand Forks, ND 58203, United States

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A B S T R A C T

Studies of neighborhood safety and physical activity have typically neglected to consider the youth’s peer context as a modifier of these relationships. This study fills this gap in testing the independent and interactive effects of perceived neighborhood safety and time spent with friends and peers on young adolescents’ physical activity and sedentary behavior. Participants (N = 80; ages 13–17) completed the Pedestrian/Traffic Safety and Crime Safety subscales of the adolescent version of the Neighborhood Environment Walkability Scale (NEWS). An experience sampling methodology was used to assess sedentary behaviors/screen time and the social context in which physical activity and sedentary time behav-tor occurred. Physical activity was assessed via accelerometry. Multilevel models were used to estimate the relationships between predictors (neighborhood safety and social context) and outcomes (physical activity and sedentary time/behavior). Frequency of peer/friend interactions moderated the relationships between neighborhood safety and adolescents’ physical activity and sedentary behavior. Specifically, physical activity was more strongly influenced by neighborhood safety among adolescents who reported spending less time with friends and peers than among those who reported frequent peer interactions. Among youths who perceived that their neighborhoods were safer, spending more time with friends and peers was related to greater engagement in sedentary activities, whereas this was not the case among adolescents who perceived that their neighborhoods were less safe. The peer social context moderates the relationship between perceived neighborhood safety and adolescents’ physical activity and sedentary behavior. Improving social interactions at the individual level within neighborhoods may decrease concerns of safety.

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1. Introduction

Regular physical activity and active play during adolescence is associated with several short- and long-term physical and psychological benefits (e.g., Janz et al., 2006). Unfortunately, many youths do not participate in recommended amounts of activity (Crespo et al., 2001) and research is needed to understand factors associated with adolescents’ choices of activities. A number of studies have focused on the associations between neighborhood characteristics, including parent perceived safety, and youths’ physical activity (Burdette and Whitaker, 2004, 2005; D’Haese et al., 2014; Galvez et al., 2013; Holt et al., 2009; Maddock, 2004; H. J. Moore et al., 2014; Morland and Evenson, 2009; Simmons et al., 2005; Weimann et al., 2015). Findings from this literature are mixed, with some studies showing relationships between neighborhood characteristics and youths’ engagement in physically active leisure activities, and others finding no or equivocal associations (e.g., Saelens and Handy, 2008). One explanation for the lack of consensus among studies may be that previous research has focused on the impact of parent perceived neighborhood safety on their children’s physical activity and sedentary behavior, and less is known about the role of youths’ perceptions of safety in relation to their own behavior (Cote-Lussier et al., 2015a; Cote-Lussier et al., 2015b). Youths’ perceptions of safety may be especially important as children get older and gain increasing autonomy. Previous models of perceived neighborhood safety have also typically neglected to consider youths’ peer and friend interactions as key modifiers of the relationships between perceived safety and physically active and sedentary activities. Adolescents spend the majority of their waking hours in the company of peers and friends. Consequently, limited social opportunities and aloneness can be decisive in narrowing adolescents’ choices of activities (e.g., Salvy et al., 2012a). Our work clearly indicates that children and adolescents’ choices of activities are strongly influenced by the presence of peers and friends. Specifically, in a series of studies we showed that spending time alone (Salvy et al., 2009; Salvy et al., 2008) and social exclusion (ostacism) decrease physical activity (Barkley et al., 2012). Conversely, co-engaging in activities with peers and friends increase youths’
motivation to be physically active and objectively measured physical activity (Barkley et al., 2014; Dunton et al., 2007; Rittenhouse et al., 2011; Salvy et al., 2008; Salvy et al., 2009; Sanders et al., 2014).

Without minimizing the impact of neighborhood safety on adolescents’ choices of activity, we hypothesize that the neighborhood environment and social factors work jointly to account for adolescents’ physical activity and health. The availability of peers and friends to engage in outdoor activities likely influence youths’ perception of safety whereas engaging in these activities alone may confer a greater feeling of vulnerability. This is important, as social relationships are arguably more amenable to change than neighborhood infrastructures. Improving social interactions at the individual level within neighborhoods may decrease youths’ feelings of vulnerability and fear for safety through collective efficacy and social cohesion (Ball et al., 2010; Foster and Giles-Corti, 2008). Conversely, policies and interventions focused on the neighborhood environment alone may not be as effective in absence of strategies simultaneously leveraging youths’ social and community relationships.

This study tests the independent and interactive effects of adolescents perceived neighborhood safety and social interactions (time alone or with peers and friends) on youth physical activity and sedentary/screen time behavior. We hypothesize that youths’ social interactions with peers and friends moderate (attenuate) the relationships between perceived neighborhood safety and engagement in physically active or sedentary activities. We focused on physical activity and sedentary behavior as both are considered important and independent determinants of adolescents’ health (Ekelund et al., 2007; Knaeps et al., 2010; Martinez–Gomez et al., 2010; Santos et al., 2014). There is also evidence that decreasing adolescents’ screen time does not automatically result in increased physical activity (Epstein et al., 2008), suggesting that physical activity and sedentary behavior may not be interdependent and influenced by different mechanisms (O’Connor et al., 2013).

2. Method

2.1. Participants and procedure

Forty pairs of same-sex biologic siblings (ages 13–17, no > 4 years apart) were originally recruited as part of a larger study evaluating putative factors contributing to differences in energy balance behaviors and adiposity among weight-discordant siblings (Feda et al., 2015). The weight-discordant sibling design increases the innovation of this study and makes it possible to control for approximately 50% of the genetic variability between siblings, and for some degree of the variance due to factors apart from shared environments.

Families were recruited from newspaper advertisements and from a database of families who had inquired about previous studies. Parents were screened by phone for their children's height, weight, a brief medical history, and ethnic background. Children were excluded if they were below the 10th BMI percentile; had current psychopathology or developmental disability; and/or if they were on medications or had conditions that could influence their mobility or their activity level (e.g., methylphenidate). If a sibling had a cold or upper respiratory distress they were rescheduled for testing. A total of 930 families contacted the study staff regarding the study. From the original pool, 234 families were screened by phone for their children’s height, weight, and adiposity among weight-discordant siblings (Feda et al., 2015). The weight-discordant sibling design increases the innovation of this study and makes it possible to control for approximately 50% of the genetic variability between siblings, and for some degree of the variance associated with shared aspects of the home and neighborhood environments.

Families were recruited from newspaper advertisements and from a database of families who had inquired about previous studies. Parents were screened by phone for their children's height, weight, a brief medical history, and ethnic background. Children were excluded if they were below the 10th BMI percentile; had current psychopathology or developmental disability; and/or if they were on medications or had conditions that could influence their mobility or their activity level (e.g., methylphenidate). If a sibling had a cold or upper respiratory distress they were rescheduled for testing. A total of 930 families contacted the study staff regarding the study. From the original pool, 234 families did not return our call or were unable to complete the initial phone screen. A large number (n = 652) of contacted families were not eligible for the study (e.g., different parents, siblings were twins). The remaining 44 families were enrolled in the study and four families dropped out before completion. All study procedures were approved by the Social and Behavioral Sciences Institutional Review Board of the University at Buffalo. Parents provided written informed consent for each sibling and the siblings provided assent.

2.2. Measures

2.2.1. Covariates

2.2.1.1. Baseline participant characteristics. Siblings were asked to report their demographic information including gender, age, grade-level, school and race/ethnicity. Parents provided parents’ education and household income.

2.2.1.2. BMI z-score (zBMI). Participants’ height and weight were assessed using an electronic scale (Model BWB-800S, Tanita, Portage, MI) and digital stadiometer (Model PE-AIM-101, Perspective Enterprises). Body weight was measured to the nearest 0.01 kg and height to the nearest 0.1 cm. Participants were asked to remove their shoes, belts, and heavy outerwear and to empty their pockets. Height was measured in duplicate and if measurements were not within 0.5 cm, we obtained a third measurement. The weight data and mean of all height measurements were used to calculate BMI (kg/m²) percentiles and z-scores (Centers for Disease Control and Prevention, 2000). BMI z-scores were entered as covariate in all analyses.

2.2.2. Outcomes

2.2.2.1. Physical activity. Physical activity was measured using the MTI Actigraph (Pensacola, FL) activity monitor. The Actigraph is a small (5.1 × 3.8 × 1.5 cm), lightweight accelerometer worn around the waist that collects measures of raw acceleration, activity amount and intensity. The Actigraph has been validated in adolescents (Robusto and Trost, 2012; Romanzini et al., 2014; Vanh selst et al., 2011). Activity was monitored and recorded for 5 weekdays and 2 weekend days. Youth received written instructions on use, including appropriate care and placement on the right iliac crest using a provided belt and had to wear the ActiGraph at least 10 h/day for the day to meet the criterion for a full measurement day. The Actigraph was initialized for 15-second epochs. Downloaded data were cleaned of spurious lines of >16,000 counts and negative counts. Sequences of 20 + min of consecutive zero counts were scored as non-wear time. The main outcome variable is the average counts/minute, an index of average total physical activity.

2.2.2.2. Sedentary behaviors/screen time. The frequency of sedentary behaviors/screen time activities was captured using an experience sampling methodology (ESM) or ecological momentary assessment (EMA). EMA/ESM have been used to study a range of phenomena in psychology and behavioral medicine (Chen et al., 2015; Csikszentmihalyi and Larson, 1987; Davidson et al., 2016; Ebner-Priemer et al., 2009; Engel et al., 2016; Huhn et al., 2016; Linas et al., 2016; Moore et al., 2016; Schuster et al., 2016). We have used this methodology to assess the relationship between social context and physical activity in young adolescents (Salvy et al., 2008) and validated this approach using objective accelerometry (Salvy et al., unpublished manuscript). In the validation study, metabolic equivalent (MET) values estimated from participants’ report of their activities based on the children’s compendium of physical activity were compared to MET values estimated from accelerometer activity counts. Both methodologies (ESM and accelerometry) yielded similar conclusions with regard to the influence of social context on youth’s physical activity. In the present study, each participant was given a cell phone to receive and send text messages related to the study. Text messages were sent to participants for 5 weekdays and 2 weekends, approximately every 2 h between 15:00 and 21:00 on weekdays, and between 10:00 and 22:00 on weekend days. The text message alerts participants to indicate the activity they were doing (e.g., screen time, eating, physical activity); the perceived difficulty of the activity (e.g., sitting, walking, running) and the duration of activity (<5 min, 6–10 min, 11–15 min, 16–20 min, 21+ min). We focused on the time engaged in screen-based activities (e.g., sending/receiving email or
text messages; watching television; or playing video games), rather than school-related activities to capture leisure-time screen usage. Research staff kept a record of participants responding. If there was an issue with the participant’s responses (e.g., missing or unclear response), the staff contacted them the next working day to clarify. In general, participants were very responsive and rarely lagged behind in sending their responses.

2.2.3. Predictors

2.2.3.1. Perceived neighborhood (un)safety. Participants completed the Pedestrian/Traffic Safety and Crime Safety subscales of the Neighborhood Environment Walkability Scale (NEWS) Adolescent version (Rosenberg et al., 2009). The seven Pedestrian/Traffic Safety items assessed traffic speed, street lighting and crosswalks in regard to impeding safety in the neighborhood (e.g., Most drivers go faster than the posted speed limits in my neighborhood). The six Crime Safety items assessed perceived crime rate and dangerousness in the neighborhood (e.g., I am worried about being in a local/nearby park because I am afraid of being taken or hurt by a stranger). The 4-point response format ranges from “strongly disagree” to “strongly agree.” The higher the score, the more participants perceived their neighborhood as “unsafe.”

2.2.3.2. Social context. The activity-related social context was captured using the EMA/ESM methodology described above. Participants were asked to report the social context (alone or with friends and peers) in which sedentary activities and physical activity occurred.

2.2.4. Analytic models

This analysis focuses on the relationships between perceived neighborhood safety and physical activity and how the presence of friends and peers (instances with friends/peers) influences this relationship. Our sample involved siblings, who are clustered within families. Consequently, multilevel models were used to estimate parameters in the presence of clustering, with random intercepts at the family level (Pituch et al., 2006; Preacher et al., 2010; Wang et al., 2011), using PROC MIXED models in the SAS software. Version 9.4 (SAS, 2013). Mixed models incorporate both random and fixed effects into the model, it assumes that the random effect (family) accounts for the correlation between measures from the same cluster. For each health behavior outcome, a main effects model was estimated (Model 1), followed by models with interaction terms: Model 2a: neighborhood safety x instances being alone; Model 2b: neighborhood safety x instances being with friends (Feng et al., 2009). The tests of the hypotheses related to main effects of predictors on outcomes were evaluated in models that did not include interaction terms. Statistically significant interaction terms were interpreted using a graphical approach. To draw the graphs, we used the “pick a point” approach (Rogosa, 1980), which involves selecting representative values (mean ± 1 SD) of the moderator and estimating the effect of the focal predictor at those values.

3. Results

3.1. Participant characteristics

The total analytic sample included 40 pairs of same-sex biologic siblings (Table 1).

3.2. Multilevel regression model results

All models controlled for siblings’ zbMI, age, gender, household socioeconomic status (SES), which includes both parents’ income and education. The coefficients for these covariates are not shown in Table 2 as these variables were not significant predictors of physical activity or sedentary behavior.

| Predictors | Physical activity | Sedentary time |
|------------|-------------------|----------------|
| Model 1 estimates (95% CIs) | | |
| Instances alone | −6.72 (−12.72, −0.71) | −0.01 (−0.49, 0.46) |
| Instances with friends/peers | 19.37 (−5.56, 44.31) | 0.98 (−0.95, 2.92) |
| Neighborhood safety | −3.88 (−12.50, 4.71) | −0.85 (−1.52, −0.18) |
| Model 2 estimates (95% CIs) | | |
| Instances alone | −7.38 (−13.25, −1.51) | −0.52 (−0.43, 0.34) |
| Instances with friends/peers | −11.50 (−51.00, 27.69) | 3.89 (1.33, 6.45)** |
| Neighborhood safety | −21.10 (−39.36, −2.79) | 1.04 (−0.06, 2.15) |
| Neighborhood safety x friends/peers | 1.63 (0.07, 3.19) | −0.17 (−0.27, −0.07)** |

Note: all models control for zbMI, age, gender, and SES which included parents’ income and education (n.s., not shown). *p ≤ 0.05; **p < 0.01. For each outcome, a main effects model was estimated (Model 1), followed by Model 2 testing the interaction of neighborhood safety by instances with friends and peers.

Table 1

Participant characteristics (n = 80).

| Outcomes | Predictors | Mean (SD; range or N%) |
|----------|------------|------------------------|
| Sedentary time (instances/week) | 23.3 (11.0; 6–61) |
| Accelerometer counts (counts/minute) | 344 (125; 161–790) |
| Perceived neighborhood safety | 21.8 (3.8; 13–31) |
| Instances with friends and peers | 8.9 (5.8; 0–25) |
| Instances alone | 10.5 (6.2; 0–27) |
| zbMI (kg/m²) | 0.78 (0.89; −1.45–2.42) |
| Household income* | 5.4 (2.8; 1–10) |
| Mother’s education** | 6.4 (1.4; 4–8) |
| Father’s education** | 5.9 (1.4; 3–8) |
| Age (years) | 15.4 (1.4; 13.0–17.8) |
| Male (n) | 46 (57.3%) |
| Race/Ethnicity | Black (n) 4 (5%) |
| Hispanic (n) | 2 (2.5%) |
| Multiracial/Other (n) | 2 (2.5%) |
| White (n) | 74 (92.5%) |

Note: *household income: 1 to 10 scale, where 1 = under $9999, 10 = over 200,000; **parents education: 1 to 8 scale, where 1 = less than 7th grade, 8 = completed graduate degree. The majority of parents (50%) had completed a 4-year degree and had an annual income between $70,000 and $89,999.

3.2. Physical activity

The number of instances youths spent alone was negatively correlated with average accelerometer counts (p = 0.03; Table 2). Importantly, time spent with peers and friends moderated the relationship between perceived neighborhood safety and physical activity in Model 2. Specifically, the (negative) relationship between neighborhood safety and physical activity was stronger among adolescents who reported spending less time with peers and friends than for those who reported frequent peer interactions (p = 0.04; Table 2; Fig. 1).

3.2.2. Hours of sedentary activities

Perceived lack of neighborhood safety (higher score = more unsafe) was negatively correlated to sedentary time in Model 1 (p = 0.01; Table 2). This relationship was subsequently qualified by time spent with friends and peers in Model 2 (p = 0.0014; Table 2; Fig. 2). Specifically, among youths who perceived that their neighborhoods were safer, spending more time with friends and peers was correlated with greater engagement in sedentary activities, whereas this was not the case among adolescents who perceived that their neighborhoods were less safe.

4. Discussion

To our knowledge, this is the first study to simultaneously consider adolescent perceived neighborhood safety and social interactions as
independent and interactive predictors of adolescents' physical activity and sedentary behavior. This study further included ESM/EMA assessment of social context and objective accelerometry to measure physical activity.

The youth social context qualifies the relationships between adolescent perceived neighborhood safety and physical activity and sedentary behavior. Importantly, neighborhood safety was predictive of physical activity only among youths who spent less time with peers and friends. For adolescents who had frequent social interactions, perceived neighborhood safety was not a significant predictor of physical activity. These findings are consistent with previous work on the beneficial influence of peers and friends on physical activity (Barkley et al., 2014; de la Haye et al., 2011; Faith et al., 2002; Gubbels et al., 2011; Larson et al., 2013; Rittenhouse et al., 2011; Salvy et al., 2012a; Salvy et al., 2008; Salvy et al., 2012b; St George and Wilson, 2012; Stock et al., 2007; Storch et al., 2007; Voorhees et al., 2005). The present study extends previous studies in indicating that positive relationships with peers and friends may buffer the potential adverse effects of neighborhood environment on physical activity. These findings are akin to those of Franzini and her colleagues who found that a favorable social environment was positively associated with physical activity, irrespective of neighborhood sociodemographic factors (Franzini et al., 2009).

Conceivably, peers and friends not only provide more opportunities to engage in physically active leisure activities, but also confer a greater sense of safety, possibly through collective efficacy and social cohesion (Ball et al., 2010; Foster and Giles-Corti, 2008).

Time spent with peers and friends also moderated the relationship between neighborhood safety and adolescents' sedentary behavior. Specifically, among youths who perceived that their neighborhoods were less safe, adolescents who had fewer social interactions spent more time engaged in screen time activities than adolescents who interacted more frequently with peers and friends. By contrast, among youths who perceived that their neighborhoods were safer, those who spent more time with peers and friends participated in more sedentary activities than youths who had fewer interactions. A recent cross-sectional study of 528 Australian children indicated that, regardless of socioeconomic status, the availability of televisions, cell phones and other screen equipment and consoles is positively associated with children’s screen time activities (Dumuid et al., 2016). Adolescents may congregate in the houses of their friends who have a greater availability and variety of video games or electronic equipment, which, in turn, may correlate with greater perception of neighborhood safety through other variables. However, this contention is purely hypothetical as socioeconomic status—a potential correlate of ownership of TVs and electronic devices—was not a significant predictor of perceived neighborhood safety, physical activity or sedentary behavior in the present study.

A possible ancillary explanation for these findings relates to social norms prevailing among friends. Adolescents tend to befriend peers who are similar or who share common interests and activities, a phenomenon known as homophily (Marks et al., 2015). Adolescents’ choice of leisure activities may be determined to a greater extent by environmental (e.g., neighborhood safety) or situational (e.g., boredom) factors when youths have few social opportunities. However, in a social context, adolescents might emulate and/or co-engage in normative behaviors that prevail in their peer group. Unfortunately, peer norms around sedentary and physically active leisure activities were not assessed in this study, so it is unclear whether activity-related norms differ as a function of participants’ perceived neighborhood safety. Though it may seem counterintuitive that greater peer interactions can be associated with both greater physical activity and greater hours of sedentary activities, there is evidence that physical activity and sedentary behavior are independent behaviors (Epstein et al., 2008), especially in youth as they have adequate free-time to be both highly active and highly sedentary (Biddle et al., 2004). Consistent with the notion of homophily, these findings may also reflect the behavior of distinct social groups who share similar interests for sedentary activities (Render and Losel, 1997; Ennett and Bauman, 1994; Lansford et al., 2009; Lodder et al., 2016; Sawka et al., 2014).

4.1. Limitations

Despite collecting real-time data and accelerometry, we cannot make definitive conclusions regarding the directionality of the associations. For instance, the finding that youth who reported being with peers and friends more frequently were more physically active than youth who had fewer social interactions could be explained by reverse causality, whereby youth who are more physically active are more frequently with peers and friends. Longitudinal work is needed in this area to help disentangle causality in social influence.

Another limitation of this study is that we measured adolescents’ perceptions of neighborhood safety rather than objectively defined neighborhood environment. Perceived and objective measures of neighborhood safety may or may not reflect similar features of the environment. Sallis and colleagues (Sallis et al., 2006) distinguish between perceptions of the environment and the objectively measured environment by placing them at different levels of influence within the ecological model of active living. In their recent review, Orstad and her
Conflict of interest

The contents of this publication do not necessarily reflect the views or policies of the USDA or the Agricultural Research Service, nor does mention of trade names, commercial products, or organizations imply endorsement from the U.S. government. USDA is an equal opportunity provider and employer.

Clinical trial registration

NCT02376439 (ClinicalTrials.gov identifier).

Transparency document

The Transparency document associated with this article can be found, in online version.

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