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## Where and when adolescents are physically active: Neighborhood environment and psychosocial correlates and their interactions



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### ABSTRACT

Female adolescents are less active than male peers in certain contexts including the neighborhood. Adolescents' physical activity can be explained by interactions between environmental and psychosocial factors, but few studies have tested such interactions in relation to context-specific behaviors. This study tested interactions between neighborhood environmental and psychosocial factors in relation to adolescents' context-specific physical activity. Data were collected in 2009–11 from 910 adolescents and a parent/guardian residing in the Baltimore/Seattle regions. Measures included adolescent-reported neighborhood leisure-time physical activity (LTPA) and non-neighborhood LTPA, accelerometer-based non-school moderate-to vigorous-physical activity (MVPA), psychosocial factors, and objective and parent-perceived neighborhood environmental factors. Gender-stratified mixed effects linear models tested associations of 6 environmental and 4 psychosocial factors and their interactions in relation to each physical activity outcome. The psychosocial factors had consistent associations with the physical activity outcomes but the environmental correlates were context-specific. Decisional balance (weighing of pros and cons of physical activity) moderated the association between recreation facility density and neighborhood LTPA among females, with a negative association only among those with high decisional balance (pros outweighed cons). Decisional balance also moderated associations of neighborhood walkability with non-school MVPA among females and non-neighborhood LTPA among males, with positive associations only among those with high decisional balance. Results support context-specific ecological models of physical activity. Targeting environmental factors that may promote opportunities for physical activity in specific contexts as well as adolescent decision-making may help promote their physical activity in those contexts, potentially leading to increased overall physical activity.

### 1. Introduction

Childhood/adolescent obesity rates over the past four decades have risen as rates of physical activity have declined, especially in areas such as active transportation (walking/bicycling), school-based physical education, and outdoor play (Bassett et al., 2015). Youth who engage in physical activity gain numerous health benefits (Ekelund et al., 2012; Janssen and Leblanc, 2010; Hallal et al., 2006) and are more likely to be physically active as adults (Hallal et al., 2006). National guidelines recommend youth engage in at least 60 min of physical activity daily, with most of that activity being of moderate-to vigorous-intensity (US

Department of Health and Human Services, 2008). Based on national surveys, only 27% of adolescents meet these recommendations, with the prevalence for males (36%) being double that of females (17%) (Kann et al., 2016). This difference may be explained partially by the higher sports participation among male adolescents (Kann et al., 2016). Female adolescents are also less active than males in specific contexts like their neighborhood and near their school (Carlson et al., 2016). Studies based on ecological models suggest that individual (e.g., socio-demographic), psychosocial, and environmental correlates of adolescents' physical activity may be gender-specific (Sallis and Owen, 2015; Patnode et al., 2010; Hearst et al., 2012; Brodersen et al., 2005). For

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example, males with higher peer social support and females with fewer barriers for physical activity are more active than their peers with less social support or more barriers, respectively (Patnode et al., 2010; Hearst et al., 2012). In another study, accelerometer-assessed moderate-to vigorous- physical activity (MVPA) among female adolescents was related to several objectively-measured environmental factors including neighborhood walkability and proximity to recreational centers, but significant environmental correlates for males' MVPA were not found (Patnode et al., 2010). Although ecological models posit that factors at multiple levels (e.g., environment and psychosocial) interact with one another to influence behavior, (Sallis and Owen, 2015) few studies have examined such interactions in relation to adolescents' physical activity within specific time and location contexts. Specifying the context in which physical activity takes place may help improve the predictive capacity of relevant correlates, and interactions among them (Giles-Corti et al., 2005)

Although some consistent psychosocial (e.g., self-efficacy) and environmental (e.g., good access to recreation facilities) correlates of adolescents' physical activity have been identified, (Sallis et al., 2016) other potential correlates have had mixed results. For example, at the psychosocial-level, fewer perceived barriers (cons) and greater perceived benefits (pros) have been linked to higher physical activity in adolescents in some studies but others report null associations (Sallis et al., 2016; Van Der Horst et al., 2007; Kim and Cardinal, 2010). The mixed findings for some of these correlates may be partly due to differences in measurement assessment of the outcome or exposure (e.g., objective vs. perceived) across studies (Ding et al., 2011). In addition, because most environment measures are specific to a certain setting such as the neighborhood and physical activity measures are typically broader (e.g., overall walking), this lack of context-specificity of the behavior may weaken the environment-physical activity associations (Giles-Corti et al., 2005). The inconsistent associations between environmental factors and physical activity may also be due to differences in population characteristics. For example, one study found moderating effects by self-efficacy (a psychosocial factor) on the association between land use mix and adolescents' self-reported active transportation, with a positive association found among those with lower self-efficacy and negative association in those with higher self-efficacy (Deforche et al., 2010)

There is some evidence of interactions between environmental and psychosocial factors in relation to adolescents' physical activity (Deforche et al., 2010; Carlson et al., 2014; D'Angelo et al., 2017). One study found interactions between several psychosocial factors (e.g., social support and friend norms) and physical activity resource availability in relation to adolescent MVPA, with stronger positive associations found among those in neighborhoods with high vs. low resource availability (D'Angelo et al., 2017). However, an important limitation of previous research is the assumption that most of adolescents' physical activity occurs in the neighborhood. No study that we are aware of has examined environment-psychosocial interactions in relation to context-specific physical activity. Evidence of such interactions may extend our understanding of factors driving adolescents to be more or less active during specific times (e.g., beyond school hours) and locations (e.g., in the neighborhood). For example, if adolescents living within easy access to parks are active in their neighborhoods only when they have high levels of social support, then interventions could be developed to target family/friends to support them to use the neighborhood parks.

In the present analysis, we focused on six neighborhood environmental and four psychosocial factors deemed pertinent to adolescent physical activity (Sallis et al., 2016). These specific factors were examined in a previous publication (Carlson et al., 2014) on adolescent active travel to/from school using data from the same larger study used in the present analysis. In that publication, the authors found only a few main effects with, and interactions between, psychosocial and environmental factors, in particular those pertinent to active travel (e.g., home/school residential density). Those findings suggest correlates

may be both domain- (transport vs. leisure) and context-specific (home/school).

The aims of the present study were to test associations of environmental and psychosocial factors, and their interactions, with adolescents' (a) self-report neighborhood leisure-time physical activity (LTPA), (b) self-report non-neighborhood LTPA, and (c) accelerometer-based non-school MVPA (i.e., beyond school hours). Further, given the evident gender differences in adolescents' physical activity, we examined these aims among males and females separately.

## 2. Methods

This cross-sectional study analyzed data from the Teen Environment and Neighborhood (TEAN) study. TEAN was an observational study of the neighborhood environment and physical activity among adolescents (aged 12–16 years) residing in the Baltimore, MD/Washington, DC and the Seattle-King County, Washington metropolitan regions.

### 2.1. Participant recruitment

As described previously, (Frank et al., 2010) the 2000 Census was used to identify 447 block groups in the Baltimore, MD/Washington, DC and Seattle/King County, WA regions that met study design criteria for household income and walkability. Median household incomes for block groups were deciled and dichotomized by median split to create low- and high-income categories. A walkability score for each block group was estimated using Geographic Information Systems (GIS) measures of residential density, street connectivity, retail floor area ratio, and land use mix (Frank et al., 2010). The block group walkability index scores were deciled and dichotomized by the median split to create low- and high-walkability categories. Using these income/walkability categories, the census block groups were grouped into one of the four quadrants: a) low income/low walkability, b) low income/high walkability, c) high income/low walkability, and d) high income/high walkability. A list obtained from a marketing company was used to identify households within each quadrant with adolescents 12–16 years of age. The study team contacted randomly-selected households via phone and mailed the occupants information about the study. Recruitment and measurement occurred across all quadrants simultaneously, but during the school year only. Adolescents were excluded if they had a condition that could affect their physical activity (e.g., physical disability), dietary habits (e.g., eating disorder), or participation (e.g., developmental disability). Out of 2619 eligible households contacted by phone, 36% agreed to enroll in the study. Participation rates were similar across the four neighborhood quadrants. The final sample included 928 adolescents and one of their parents/guardians. Parent informed consent and adolescent assent were obtained in writing and the Institutional Review Boards of the participating institutions approved the study.

### 2.2. Data collection

Data were collected between 2009 and 2011. Participating adolescents wore an accelerometer and completed a survey assessing physical activity, psychosocial factors, perceived neighborhood environment, and socio-demographics. One parent/guardian of each participant completed a separate survey assessing similar variables.

### 2.3. Measures

Table 1 describes the survey and objective measures. In brief, adolescents reported their frequency of *neighborhood leisure-time physical activity (LTPA)* (Sallis et al., 1993) (Cronbach's alpha = 0.81) and *non-neighborhood LTPA* (Sallis et al., 1997) (Cronbach's alpha = 0.80). We averaged the ordinal response categories across the set of items used for each scale. These mean scores can be interpreted as indicators of

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