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Adolescent Physical Activity: Moderation of Individual Factors by Neighborhood Environment

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Abstract

Introduction—Less than a third of U.S. adolescents meet federal physical activity (PA) guidelines. Understanding correlates of PA at multiple levels of the Social Ecological Model could improve PA interventions among youth. This study examines: (1) associations between factors across the Social Ecological Model including psychosocial factors, perceived neighborhood physical and social environment characteristics, and adolescent moderate/vigorous PA (MVPA); and (2) whether perceived neighborhood characteristics moderate associations between psychosocial factors and MVPA.

Methods—A national sample of adolescents (aged 12–17 years) in the 2014 Family Life, Activity, Sun, Health, and Eating Study was used to examine associations between psychosocial characteristics, perceived neighborhood social and physical characteristics, and self-reported weekly minutes of MVPA. Analyses were conducted in 2015. Interaction terms between psychosocial and neighborhood variables were added to multiple linear regression models to examine moderation hypotheses.

Results—Significant two-way interactions revealed that neighborhoods with features perceived as supportive of PA strengthened several psychosocial–MVPA associations. The positive associations between MVPA and friend norms, friend support, and attitudes were strengthened for adolescents living in neighborhoods with high versus low PA resource availability (all $p < 0.05$). Furthermore, the association between controlled and autonomous motivation and MVPA was strengthened under conditions of shops/stores near (versus distant from) adolescents' homes ($p < 0.05$).

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Conclusions—The association between some psychosocial factors and adolescent MVPA may be environment dependent. Neighborhood physical and social environments supportive of PA are important to consider when developing targeted PA interventions, and may strengthen the association between psychosocial-level factors and adolescent MVPA.

INTRODUCTION

Obesity in youth tracks into adulthood,¹ and can lead to chronic conditions.² Physical activity (PA) is associated with reduced risk of obesity, cardiovascular disease, diabetes, and several common cancers.^{3,4} However, only 29% of high school students in the U.S. reported meeting guidelines of at least 60 minutes of moderate to vigorous PA (MVPA) per day.⁵ PA early in life tracks into adulthood⁶; therefore, being active at a young age can serve as a protective effect against later chronic disease.² Examining factors related to adolescent PA is necessary for developing effective interventions to increase PA at this critical life stage.

The Social Ecological Model (SEM) employs a multilevel approach to examining determinants of health behaviors,⁷ and has been applied to neighborhood/environmental, social/interpersonal, and intrapersonal correlates of MVPA.⁸ Several literature reviews^{9–11} have identified features of the neighborhood social and physical environment that either support or are barriers to MVPA. Supportive features, such as mixed land use (e.g., neighborhood destinations) and access to parks and recreation facilities (e.g., living near green space and proximity to recreation facilities) are positively associated with MVPA, whereas barriers, including crime and traffic speed, have an inverse association.⁹ Psychosocial factors have also been associated with youth PA behaviors.¹² However, some findings have been inconsistent in their relationship with adolescent MVPA.^{9,10} For example, social support is consistently and strongly related to greater adolescent MVPA; associations between motivation and attitudes are less consistent.¹⁰ Given that both neighborhood environments and psychosocial factors are important for adolescent PA, understanding how these factors might interact is of great interest.

Although it is a key principle of ecological models of health behaviors,^{7,11} and has been examined among adults,¹³ few researchers have examined the interaction of environmental and psychosocial factors in association with adolescent PA.^{14,15} One study of Belgian adolescents found access to recreational facilities was only associated with active transportation among those with low self-efficacy.¹⁶ Therefore, though studies have examined this type of moderation hypothesis, most are among adults and all adolescent studies have been outside the U.S.

This study examined: (1) associations between psychosocial factors and perceived neighborhood environment characteristics and adolescent MVPA; and (2) whether perceived neighborhood characteristics moderate associations between psychosocial factors and MVPA. The hypothesis is that living in neighborhoods perceived as having features supportive of PA will strengthen the positive associations between psychosocial factors and adolescent MVPA.

METHODS

Study Sample

This study is a secondary analysis of the National Cancer Institute's Family, Life, Activity, Sun, Health, and Eating (FLASHE) Study. FLASHE is a cross-sectional survey administered to dyads of parents and their adolescent child (aged 12–17) between April and October 2014 to examine multiple cancer preventive behaviors and their correlates. Parent participants were recruited to the study through the Ipsos Consumer Opinion Panel, a national market research firm, and were eligible if they were aged 18 years and lived with at least one child aged 12–17 years for at least 50% of the time. During screening, one eligible adolescent from the household was randomly selected for the study. FLASHE was reviewed and approved by the U.S. Government's Office of Management and Budget, the National Cancer Institute Special Studies IRB, and the Westat IRB. The FLASHE study design and measures development are described in more detail in this journal issue.¹⁶

Among the 1,737 adolescents in FLASHE, 1,358 had complete data for MVPA. An additional 95 adolescents were excluded from analyses owing to missing data on demographics, psychosocial, or neighborhood variables, leaving a final sample of 1,263.

Measures

In this study, PA was defined as estimated minutes of MVPA. The self-reported Youth Activity Profile (YAP)¹⁷ survey items in FLASHE included a 15-item PA questionnaire that asks about activity patterns both during and out of school the previous week, and was designed to provide independent estimates of activity in different settings. The YAP was chosen because it is a validated web-based self-report instrument (consistent with the survey mode) that could be calibrated with objectively measured PA.¹⁸ The school section includes items about activity while commuting to/from school, at physical education, recess/study breaks, and at lunch. The out-of-school section includes activity before school, after school, evening, and each Saturday and Sunday. The YAP was scored and calibrated to convert raw YAP scores to estimated minutes of MVPA. A calibration model was developed using data from a subset of FLASHE adolescents who participated in accelerometry data collection.¹⁹ Estimated minutes of weekday MVPA were used as the outcome in this study.

All measures were developed and reviewed for consistency with existing validated measures.¹⁶ Friend support, friend norms, barriers, attitudes, motivation, and self-efficacy were measured on 5-point Likert scales (1=*strongly disagree*, 5=*strongly agree*). Friend support was measured by one item: *My friends play sports/are physically active with me*. Friend norms were assessed by one item: *My friends exercise most days of the week*. Self-efficacy was assessed with a single item: *I feel confident in my ability to exercise regularly*.

Five items assessed barriers, each beginning with the statement: *I don't exercise as much as I'd like to because...* and followed by: *I don't like to sweat*, *I don't like to exercise*, *I don't want to mess up my hair*, *my family doesn't like to exercise*, and *I'm not athletic*. Barrier items were combined into a mean score ($\alpha=0.77$). Five items assessed attitudes, each beginning with the statement: *If I were to be physically active on most days, it would... be fun*, *help me cope with stress*, *help me make new friends*, *make me more good looking*, and

make me better in sports, dance, or other activities. Attitudes items were combined into a mean score ($\alpha=0.78$). Motivation items began with the phrase: *I would exercise most days of the week because...* The two items assessing autonomous motivation were followed by: *I have thought about it and decided that I want to exercise*, and *it is an important thing for me to do*, and were combined into a mean score ($r=0.71$). Two items assessed controlled motivation and were also combined into a mean score: *I would feel bad about myself if I didn't and others would be upset with me if I didn't* ($r=0.53$).

Perceptions of the neighborhood environment were assessed in terms of the social and physical environmental characteristics that support (or are barriers to) MVPA. Perceptions were assessed following this prompt: *Please tell us about your neighborhood. Your neighborhood is the local area around your home, within a 10–15-minute walk in any direction.* Three measures were created in the following domains: safety, walkable destinations, and PA resource availability.

Two items were combined into a mean score to create the variable, safe for walking: *the crime rate in my neighborhood makes it unsafe to go on walks at night and there is so much traffic along nearby streets that it makes it difficult or unpleasant to walk in my neighborhood* (1=strongly disagree, 4=strongly agree; $r=0.59$). One item measured walkable destinations, specifically, whether there were shops/stores nearby to walk to: *many shops, stores, markets or other places to buy things I need are within a 10–15-minute walk of my home* (1=strongly disagree, 4=strongly agree). Five items assessed availability of PA resources. Adolescents selected all available in their home neighborhood from the following list: indoor recreation or exercise facility (public or private); school with recreation facilities open to the public; bike/hiking/walking trails, paths, basketball courts; running track/other playing fields (like soccer, football, softball, tennis, skate parks); and public parks. The five items were summed to create a PA resource availability index (range, 0–5).

Items were reverse coded so that higher scores corresponded to environments more supportive of PA. The median of each of the three environmental variables was used as a cut off to create dichotomous “supportive” versus “non-supportive” neighborhood environment variables.

Adolescent demographics used as covariates in the regression models included: age, gender, race/ethnicity, parent education level, and BMI.

Statistical Analysis

Data were analyzed using Stata, version 13.0 in 2015. Descriptive statistics of each psychosocial and environment variable were calculated. A multiple linear regression model was used to examine the association of psychosocial characteristics and perceptions of the environment with MVPA, adjusted for covariates. Interaction terms were then added to the model individually for each psychosocial/neighborhood environment combination. The psychosocial measures were mean centered. Graphs of each significant interaction ($p<0.05$ for the interaction term) were created using the marginsplot command in Stata to examine interactions between psychosocial variables and MVPA at each level of the neighborhood environment constructs (supportive versus non-supportive).

RESULTS

Adolescents in the sample were evenly distributed by gender and age (Table 1). The majority of adolescents were non-Hispanic white (64.4%) followed by non-Hispanic black (16.2%) and Hispanic (10.5%); the remainder identified as another race/ethnicity. Almost half of the adolescents' parents had at least a college degree (47.3%), and about a third had completed some college. Less than half of adolescents reported they had shops or stores near their homes that they could walk to (45.0%), felt that their neighborhood was safe for walking at night (47.5%), and had three or more PA resources near their homes (42.0%). On average, adolescents completed 574 (range, 386–899) estimated minutes of MVPA per week.

A multiple linear regression model was used to examine associations between psychosocial and perceived neighborhood environment characteristics and estimated MVPA, adjusted for covariates (Table 1). Estimated MVPA was significantly lower for adolescents aged 14–15 and 16–17 years compared with those aged 12–13 years ($B = -95.9$ and -188.5 , respectively, $p < 0.001$). Adolescents whose parents had completed some college ($B = 9.5$, $p < 0.05$) and only a high school education ($B = 8.9$, $p < 0.05$) had significantly higher estimated MVPA compared with adolescents whose parents had a college degree or more education.

All psychosocial characteristics were significantly associated with estimated MVPA, with the exception of friend norms and autonomous motivation. Self-efficacy was the strongest psychosocial predictor ($B = 8.6$, $p < 0.001$). Adolescents reporting shops/stores were nearby and high PA resource availability also had significantly higher MVPA than adolescents without shops/stores nearby and low PA resource availability, respectively, ($B = 11.1$, $p < 0.01$; $B = 7.3$, $p < 0.05$). However, neighborhood safety was not significantly associated with MVPA.

Next, interaction terms between each psychosocial and neighborhood environment characteristic were added separately to the adjusted model; graphs showing the significant interactions (at $p < 0.05$) are shown in Figure 1. Significant interactions were found between PA resource availability and friend norms, friend support, and attitudes. Only when adolescents had high versus low PA resource availability were friend norms positively associated with estimated MVPA ($p = 0.02$ for interaction term); otherwise, there was no association. In addition, high PA resource availability strengthened the positive association between both friend support ($p = 0.03$) and attitudes ($p = 0.04$) and MVPA. Two significant interactions emerged between the neighborhood-level variable, having shops/stores nearby, and autonomous and controlled motivation. The association between autonomous motivation and MVPA was positive for adolescents with shops/stores within walking distance of home ($p = 0.02$), but there was no association for adolescents reporting shops were not nearby. Moreover, having shops/stores nearby strengthened the positive association between controlled motivation and MVPA ($p = 0.03$). There were no significant interactions between neighborhood safety and any psychosocial characteristics, and there were no significant interactions between self-efficacy, barriers, and any neighborhood environment characteristic.

DISCUSSION

This study examined independent and moderated associations between psychosocial factors and the neighborhood physical/social environment on estimated MVPA in a national sample of adolescents. Similar to previous studies,^{9,10} psychosocial factors and perceived neighborhood environments were associated with adolescent MVPA, in the expected directions. For example, estimated weekly minutes of MVPA were higher for adolescents reporting three or more PA resources near their home (versus two or fewer) and among those who agreed that there were many shops/stores nearby to which they could walk (versus disagreed). However, perceived safety was not associated with estimated MVPA, in contrast to previous findings.⁹ The FLASHE sample was predominantly white, suburban, with a high level of parental education, which may have reduced variability in the items that comprised the safety measure.

The moderation hypothesis was supported for some, but not all psychosocial–environment combinations. Associations between friend support, attitudes, and estimated MVPA were strengthened when PA resource availability was high, and only when adolescents had high PA resource availability were friend norms and estimated MVPA positively related. Living in a neighborhood with more PA resources nearby may provide more opportunities to be physically active with friends. A study examining park use found that the positive association between park programming (e.g. social activities) and girls' PA was stronger when there were more recreational facilities available,²⁰ lending support to the hypothesis that PA resource availability may strengthen social influences on PA. Adolescents with greater friend support and more-positive attitudes may be more aware of and use nearby PA resources more frequently. Given the study's cross-sectional nature, it is not possible to ascertain whether living near more PA resources influences PA supportive norms. Future studies using longitudinal data or a natural experiment examining the construction of a new PA facility may elucidate these mechanisms.

The availability of shops and stores in the neighborhood moderated associations between estimated MVPA and both autonomous and controlled motivation. Perceiving shops and stores nearby may indicate a more walkable neighborhood^{21,22} and this finding may be capturing MVPA as part of active transportation. Interestingly, the associations between both self-efficacy and barriers to PA and MVPA were not moderated by neighborhood or social environment characteristics. Perhaps self-efficacy and barriers are less context specific, and more proximal to the behavior than norms, support, attitudes, and motivation, which may be more influenced by context.

The MVPA measure aggregated activities ranging from bicycling, playing team sports, or walking to school. It is possible that different aspects of the neighborhood environment may operate differently based on the type of activity contributing to the total minutes of weekly estimated MVPA, consistent with the observed interactions. For example, perhaps high PA resource availability is more conducive to social activities like team sports than to activities that can be performed alone, like bicycling or active transportation. Estimated MVPA decreased with age, and this finding has been demonstrated elsewhere.²³ Parental education was also inversely associated with MVPA. Previous studies have found that active

commuting is inversely associated with parental education²⁴ and living in urban areas.²⁵ Given that this was a national sample of adolescents, perhaps adolescents whose parents have lower education levels resided in cities where active commuting is more common compared with suburban areas that tend to be less walkable.

Limitations

The FLASHE Study is a large, national sample of adolescents, and measured a wide range of psychosocial and environmental correlates of PA. FLASHE is cross-sectional and therefore cannot assess causality. For example, families of adolescents who are more active may have self-selected into neighborhoods more supportive of PA, and the authors are unable to disentangle residential self-selection with a cross-sectional design. FLASHE measured perceptions of the neighborhood and environment, which have been shown to differ from objective measures in their association with each other²⁶ and with adolescent MVPA.^{9,27,28} For example, adolescents' perceived availability of parks and PA facilities had a stronger association with engaging in sports, cycling, and walking than did objectively measured access.²⁹ Perceived and objective measures are likely capturing different dimensions of context in which people live and should therefore be included in future research when possible. Family/parental support was not measured. However, leaving out parental support should not affect the association between friend support and PA, as the measure is specific to friends and the type of support provided (doing activities together). Further, the barriers scale captured a type of family support (*my family doesn't like to exercise*).

Weekday MVPA was aggregated across in-school and out-of-school minutes, which allowed the study to capture comprehensive estimate of total weekday MVPA. However, FLASHE did not assess school equipment or facilities, which might influence adolescent MVPA.³⁰ Adolescents were prompted to anchor on the area around their home, and not around their school, when thinking about different aspects of their neighborhood, consistent with the literature.⁹ However, half of participants' homes were located less than 2 miles from their school, with more than 25% living within 1 mile of their school. Active travel was not able to be separated from other active behaviors, although all were included in the total MVPA measure. Finally, though MVPA was a self-report measure, it was calibrated using objectively measured PA among a subsample of adolescents. Device-based measures often yield lower estimates of MVPA than do self-reported measures³¹; therefore, the current findings may differ from using a device without self-report.

CONCLUSIONS

Both psychosocial and neighborhood level factors were associated with adolescent MVPA, with some, but not all, psychosocial factors being dependent on neighborhood environment. Interventions aimed at increasing adolescent PA should, at a minimum, measure characteristics of the neighborhood physical and social environment that have been associated with PA, especially the availability of PA resources and walkable destinations. When environmental change is not feasible, or in places with few PA resources and low walkability, interventions targeting self-efficacy and reducing perceived barriers to PA may

have a positive influence on PA. However, perceiving that one's neighborhood is supportive of PA appears to strengthen the association between important cognitive factors and adolescent MVPA. Future outreach efforts could increase awareness and use of local PA resources. Community PA programs could establish and promote social norms and provide opportunities for friend support around PA. These efforts combined with zoning and planning to create neighborhoods supportive of PA may enhance associations with adolescent MVPA that exist at the individual level.

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Figure 1. Moderating effect of physical activity (PA) resource availability (top) and shops/stores within walking distance of home (bottom) on the association between psychosocial characteristics and minutes of weekly adolescent moderate to vigorous physical activity (MVPA). All interactions are significant at $p < 0.05$.

Table 1

Descriptive Statistics and Results of the Multiple Linear Regression Model With Correlates of Teen Total Weekly Minutes of MVPA (Weekdays in and out of School) N=1,263

Characteristics	Mean (SD) or N (%)	B	SE
Intercept		659.5***	4.3
Psychosocial characteristics ^a			
Friends support PA	3.8 (1.2)	6.8***	1.7
Friends exercise most days (norms)	3.5 (1.2)	1.7	1.6
Barriers	2.3 (0.9)	-5.2**	2.0
Attitudes	3.9 (0.8)	5.7*	2.4
Autonomous motivation	3.9 (0.9)	1.3	2.3
Controlled motivation	2.8 (1.0)	4.1*	1.6
Self-efficacy	3.9 (1.1)	8.6***	1.8
Perceptions of neighborhood environment ^a			
Shops/stores nearby ^b	566 (45.0)	11.1**	3.0
Safe for walking ^b	600 (47.5)	-3.6	3.0
High PA resource availability ^c	530 (42.0)	7.3*	3.0
Covariates			
Female (vs. male)	636 (50.4)	-5.3	3.0
Age 12–13 years	452 (33.3)	ref	
14–15 years	466 (34.3)	-95.9***	3.5
16–17 years	440 (32.4)	-188.5***	3.6
Race/Ethnicity			
Non-Hispanic white	813 (64.4)	ref	
Non-Hispanic black	204 (16.2)	0.6	4.1
Hispanic	132 (10.5)	-0.5	4.8
Other race/ethnicity	114 (9.0)	5.3	5.1
BMI (kg/m ²) ^d	22.2 (4.9)	-0.2	1.3
Parent education			
College degree or higher	597 (47.3)	ref	
Some college, no degree	435 (34.4)	9.5*	3.3
High school/GED or less	231 (19.6)	8.9*	4.0
R-squared		0.7263	

Notes: Boldface indicates statistical significance (* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$).

^aMeasured on 1 to 5 scale with higher being more agreement.

^bIn regression model, used median cutoff, reference is low agreement.

^cHigh (3–5), vs. low (0–3 resources), reference.

^dMean BMI presented, but BMI z-score used in analyses.

MVPA, moderate to vigorous physical activity; PA, physical activity; GED, General Educational Development