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ORIGINAL RESEARCH

Perceptions of the Neighborhood Environment and Children's Afterschool Moderate-to-Vigorous Physical Activity

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Previous research suggests the neighborhood environment may be an important influence on children's physical activity (PA) behaviors; however, findings are inconsistent. The purpose of this study was to further understand the relationship between perceptions of the neighborhood environment and children's afterschool moderate-to-vigorous PA. Utilizing a structural equation modeling technique, we tested a conceptual model linking parent and child perceptions of the neighborhood environment, parent support for PA, and child outdoor PA with children's afterschool moderate-to vigorous PA. We found that child perception of the neighborhood environment and outdoor PA were positively associated with afterschool moderate-to-vigorous PA. In addition, parent support for PA positively influenced children's outdoor PA. The neighborhood environment and outdoor activity appear to play an influential role on children's afterschool PA behaviors.

Keywords: exercise, school, youth, parent, outdoors

Studies have shown that moderate-to-vigorous physical activity (PA) is associated with numerous health benefits in youth (24,25,43). On the basis of this evidence, the United States Department of Health and Human Services developed physical activity guidelines which recommend that youth engage in at least 60 min of moderate-to-vigorous PA daily (53). However, national surveillance studies suggest that the majority of children (58%) do not meet this guideline (47). The social ecological model (29,42) suggests that factors at multiple levels (e.g., individual, social, environmental) influence PA behavior, and research indicates that the neighborhood environment may be an important setting for increasing children's PA (13,26). In addition to the influence of neighborhood, other social and behavioral factors (e.g., parent support and outdoor PA) may play an important role with regard to children's moderate-to-vigorous PA (36,37).

While several studies have examined the association between the neighborhood environment and PA in youth, the results have been inconsistent, perhaps in part because most of the previous research has focused on either the child's or the parent's perceptions of the neighborhood environment, but not both. It is important to consider both these perceptions because they may influence moderate-

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to-vigorous PA behavior either directly (a child decides to avoid an unpleasant or unsafe PA setting) or indirectly (a parent discourages or supports a child's activity, based on the safety of the setting). In addition, the few studies that have assessed both parent and child perceptions of the neighborhood environment found conflicting results with regard to the influence of the child's perception of this environment on active commuting to school (44,46). Moreover, the focus of these studies was primarily on the influence of the neighborhood environment on active travel to school and, as such, the impact of the neighborhood environment, perceived by the parent and the child, on children's moderate-to-vigorous PA behavior remains unclear.

Further, inconsistent findings may also be related to past studies not considering other factors known to influence children's moderate-to-vigorous PA (e.g., parent support and children's outdoor PA activities) (10,27), in addition to perceptions of the neighborhood environment. Evidence suggests that children's time spent outdoors is associated with increases in moderate-to-vigorous PA. For example, Cleland et al. (2008) found that an extra hour of time spent outdoors during the weekend and on weekdays resulted in substantial increases in moderate-to-vigorous PA for boys and girls, 21.0 min and 26.5 min per week, respectively (8,9). In addition, past research suggests that parent support for physical activity positively influences not only children's overall PA (50) but also time spent outdoors (10).

Moreover, past studies of the neighborhood environment and children's PA have focused on the impact of the environment on total day PA (19,23,54); however, it is also important to understand the potential effects of this environment on PA across different times of the day (e.g., afterschool hours). Evidence suggests that the afterschool period (3:00 p.m. to 6:00 p.m.) is the time period when youth are most likely to participate in moderate-to-vigorous PA (2) and accumulate up to 50% of their total PA (31,49). In addition, considering a large proportion of youth do not attend afterschool programs and likely return home (supervised or unsupervised) during the afterschool hours (1), the neighborhood environment may exhibit a profound influence on moderate-to-vigorous PA behavior during this time period (26).

Collectively, the absence of information regarding both the parent and child perceptions of the neighborhood environment, the exclusion of established correlates of moderate-to-vigorous PA (i.e., parent support and outdoor time) and the focus on total day moderate-to-vigorous PA versus a specific time period (i.e., afterschool) may, in part, explain the limited knowledge that currently exists in the literature regarding the relationship between the neighborhood environment and children's moderate-to-vigorous PA behavior. Therefore, the purpose of this study was to gain a better understanding of this relationship by developing and testing a conceptual model linking parent and child perceptions of the neighborhood environment, parent support for PA and child outdoor activities with children's afterschool moderate-to-vigorous PA.

Methods

Participants and Settings

Data were drawn from the Transitions and Activity Changes in Kids (TRACK) study, a longitudinal study that is examining changes in factors that influence children's physical activity levels as they advance from elementary to middle school. After obtaining approval from two school districts in South Carolina, 24 elementary schools were invited to participate in the study. Twenty-one schools, 14 out of 17 schools in one district and all 7 in the other, agreed to take part in the study. Children were recruited from the 21 public elementary schools through recruitment assemblies which invited all 5th grade students to participate. Further details regarding recruitment of the schools and children are reported elsewhere (35). Before participation in the study, parental written consent and child assent were obtained. This study was approved by the University's Institutional Review Board.

For the purposes of this paper, we employed a cross-sectional design and analyzed only the 5th grade baseline data. The initial recruitment for TRACK yielded 1083 5th grade students. Children were excluded from the analyses if they were missing data from at least one of the following measures: accelerometry (n = 103), the Physical Activity Choices (PAC) survey (n = 251), or the parent support and neighborhood survey (n = 130); the final analysis sample included 599 children (273 males and 326 females). Sex and race/ethnic distributions were similar between children excluded from the analyses and the final sample.

Measures and Instruments

Physical Activity. Physical activity was measured via accelerometry (Actigraph GT1M and GT3× models, Fort Walton Beach, FL). The Actigraph accelerometers have been validated previously in children and have acceptable correlations with energy expenditure and strong intra- and interinstrument reliability (30,34,51). Children were instructed to wear the monitor for seven consecutive days during most waking hours, except while engaging in water-based activities (e.g., showering, swimming). Before data collection, the monitors were initialized and set to begin collecting data at 5:00 a.m. on the day following distribution of the monitors. Data were collected and stored in 1-min epochs. Any period of 60 or more minutes of consecutive 0's was classified as nonwear time.

Age-specific criteria for thresholds to distinguish between sedentary, light, moderate and vigorous activity were used (21,48). The following cut-points and the corresponding thresholds were used: sedentary (0–100 counts/min), light (100–2199 counts/min), moderate (2200–5099 counts/min) and vigorous (>5100 counts/min). Missing values were estimated for children who had at least two days of eight hours of accelerometer wear time, using a sex-specific multiple imputation technique via PROC MI in SAS (Version 9.0, SAS Institute, Inc., Rockville,

MD) (14). Afterschool physical activity was defined as the hours between 3:00 and 6:00pm on all weekdays and total hours for Saturday. Sunday was excluded from the analyses, as the amount of data recorded for this day was minimal. Physical activity was expressed as minutes of daily moderate-to-vigorous physical activity divided by daily wear time and was square root transformed to normalize the scores.

Parent Survey

Perception of Neighborhood Environment. Parents completed a 61-item survey which included questions related to their personal and their child's health behaviors. Three items related to parents' perception of their child's neighborhood environment were selected for this analysis. Two questions inquired about the safety of the neighborhood in regard to outdoor activity (e.g., "It is safe for this child to play outdoors with other children in the neighborhood without adult supervision") and nearby parks (e.g., "The public park nearest to your home has a reputation of being…?"). One question addressed whether parents see other children playing outside (e.g., "I often see other children playing outdoors in my neighborhood"). The response format for the questions was a 5-point Likert scale. Possible responses differed, depending on the question (e.g., *very unsafe* to *very safe* and *strongly disagree* or *strongly agree*). The items from this survey were taken from the Amherst Health and Activity Study parent survey, which has been validated previously (38).

Child Survey

Perception of Neighborhood Environment. Children completed a 168-item survey which included questions about psychosocial, environmental, and behavioral factors related to their physical activity. Twelve items were selected which addressed the following categories of neighborhood characteristics: safety of the environment (e.g., "There is a lot of crime in my neighborhood"), aesthetics of the environment (e.g., "There are many interesting things to look at while walking in my neighborhood"), facilities near the home (e.g., "There are playground, parks or gyms close to my home that I can get to easily"), and transportation ("There are many places I like to go within easy walking distance of my home"). The response format for all the questions was a 5-point Likert scale, with possible responses ranging from *disagree a lot* to *agree a lot*. The neighborhood environment survey items were taken from two validated surveys, the Amherst Health and Activity Study parent survey and the Trial of Activity in Adolescent Girls (TAAG) student survey (17,38). Reliability was assessed for this study sample (Cronbach's $\alpha = 0.73$).

Perceived Parent Support

Children reported parental support for physical activity using 5 items selected from the child survey. These items have been found to be reliable (Cronbach's $\alpha = 0.78$; ICC = 0.81) (38), and reliability of the items was assessed separately for this sample (Cronbach's $\alpha = 0.89$). The parental support questions asked children to report how frequently, during a normal week, their parents did the following: encourage you to do physical activities or play sports?; do a physical activity or play sports with you?; provide transportation to a place where you can do physical activity or play?; watch you participate in physical activities or sports?; tell you that you are doing well in physical activities or sports? The response format for the questions was a 5-point Likert scale, with possible responses ranging from *none* to *daily*.

Outdoor Physical Activity

To assess outdoor physical activity, children completed a Physical Activity Choices (PAC) survey. The children recorded the frequency (in days) of the activities they had participated in during the past five days. The survey consisted of a checklist of 61 activities (9 sedentary activities and 52 physical activities). For the purposes of the present analyses, only the 33 physical activities most likely to be performed outdoors were used (e.g., bicycling, skateboarding, hiking, etc.). To determine outdoor physical activity, the frequency (number of days recorded) for each outdoor physical activity per child was used.

Demographic Characteristics

As part of the child survey, children were asked about their age, sex, grade level, and race/ethnicity. For race, they were instructed to choose all categories that applied to them (i.e., American Indian or Alaskan Native, Black/African American, Native Hawaiian or other Pacific Islander, White, Asian or other). For ethnicity, children were asked to indicate whether they were Hispanic or Latino (Y/N). Race/ethnicity was condensed to four categories: Non-Hispanic white, Non-Hispanic black, Hispanic and Other. Any child reporting Hispanic was placed in the Hispanic category regardless of race. In addition, children reporting multiple races or American Indian/Alaskan Native or Native Hawaiian, Asian or other, were categorized as Other. Lastly, children who reported only white or black race were placed into those categories. As part of the parent survey, the parents were asked to report their highest level of education to indirectly estimate socioeconomic status.

Statistical Analysis

Structural equation modeling was used to test the hypothesized model presented in Figure 1, using robust weighted least squares estimation with mean- and variance-adjusted chi-square test (WLSMV) (because of binary covariates) and full information imputation of missing values (1.8%) in M*plus*. 7.11 (16,32). Critical z-scores (parameter estimate/*SE*) were used to test significance of relations (fully standardized b coefficients) between variables ($p < .05$).

Factor structures were specified and relations among the latent variables were freely estimated. The model included three latent variables and one observed variable: child perception of the neighborhood environment (9 indicators) and perceived parent support for PA (5 indicators) were modeled as correlated exogenous variables. Child moderate-to-vigorous PA (6 indicators) and child outdoor PA (1 indicator [observed variable]) were modeled as endogenous variables. The structural model included (a) three direct paths: child perception of the neighborhood environment to child afterschool moderate-to-vigorous PA; parent support for PA to child afterschool moderate-to-vigorous PA; and child outdoor PA to child afterschool moderate-to-vigorous PA. In addition to assessing the direct paths, two indirect paths were also tested: child perception of the neighborhood environment to child afterschool moderate-to-vigorous PA, mediated by child outdoor PA, and parent support for PA to child afterschool moderate-to-vigorous PA, mediated by child outdoor PA. All analyses were adjusted for sex, race/ethnicity, and parental education.

Model fit was assessed using multiple fit indices. The χ^2 statistic is commonly used to assess overall model fit. However, because of its high sensitivity in large samples (4), the comparative fit index (CFI), the nonnormed Tucker-Lewis index (TLI), and root mean square error of approximation (RMSEA) were used to more fully assess model fit. CFI tests the proportionate improvement of fit in the target model with the null model (3). The TLI is also an incremental fit index but more stringently adjusts for model complexity. CFI and TLI values greater than or equal to 0.90 represent adequate fit. RMSEA assess how well the hypothesized model fits the population covariance matrix; RSMEA values less than or equal to 0.06 represent a good fit (22).

In the initial structural equation model (not presented here), parent perception of the neighborhood environment was included in the model. It was redundant with child perception of the neighborhood environment (r = .98; $p < .0001$) and theoretically less plausible as a causal influence. Thus, parent perception of the neighborhood environment did not offer any additional information to the model and was eliminated.

Results

Demographic characteristics of the 5th grade sample are presented in Table 1. The sample consisted of 599 fifth grade students with an average age of 10.5 years (± 0.5 years). Roughly 46% of the sample was male, and the average body mass index was 21.0 kg/m^2 (± 5.0 kg/m^2). The racial/ethnic composition of the sample was 37% Black, 36% White, 11% Hispanic and 16% other. A majority of the children's parents (64%) did not earn a college degree. The average time (in minutes per hour) spent in moderate-to-vigorous PA during afterschool hours (3:00–6:00 p.m.) was 3.4 min (± 2.6 min).

The structural equation model, presented in Figure 1, illustrates the relationships among the child's perceptions of the neighborhood environment, parent support for PA and outdoor PA on the child's afterschool moderate-to-vigorous PA adjusted for sex, race/ethnicity, and parental education. The model provided an acceptable fit (χ^2_{269} = 409.5, $p < .001$), CFI = 0.936; TLI = 0.922; RMSEA = 0.030 (95% CI: 0.024–0.035). A significant direct and positive relationship was found between child perception of the neighborhood environment and child's afterschool moderate-to-vigorous PA ($\beta = 0.12$; $p = .05$). Similarly, a significant direct relationship between child outdoor PA and child afterschool moderate-to-vigorous PA was found ($\beta = 0.09$; $p = .034$). The direct relationship between parent support for PA and child afterschool moderate-to-vigorous PA was nonsignificant ($\beta = 0.04$; $p = .455$).

Table 1 Baseline (5th Grade) Sample Characteristics by Total Group and Sex

	Total (n = 599)	Males (n = 273)	Females (n = 326)
Mean Age (years)	10.5 ± 0.5	10.5 ± 0.5	10.5 ± 0.5
Body Mass Index (kg/m^2)	21.0 ± 5.0	20.6 ± 5.0	21.3 ± 5.0
Race/Ethnicity			
Black	37.0%	40.6%	34.0%
White	35.9%	31.8%	39.2%
Hispanic	10.7%	12.5%	9.3%
Other	16.4%	15.1%	17.5%
Parent Education			
No college degree	63.9%	62.8%	64.9%
College degree	36.1%	35.1%	37.2%
Physical Activity[a] (min/hr)			
Afterschool MVPA	3.4 ± 2.6	4.4 ± 3.1	2.5 ± 1.8

Note. MVPA = moderate-to-vigorous PA.

[a]Afterschool MVPA was delimited to the hours of 3:00 PM to 6:00 PM Monday through Friday and total hours worn on Saturday.

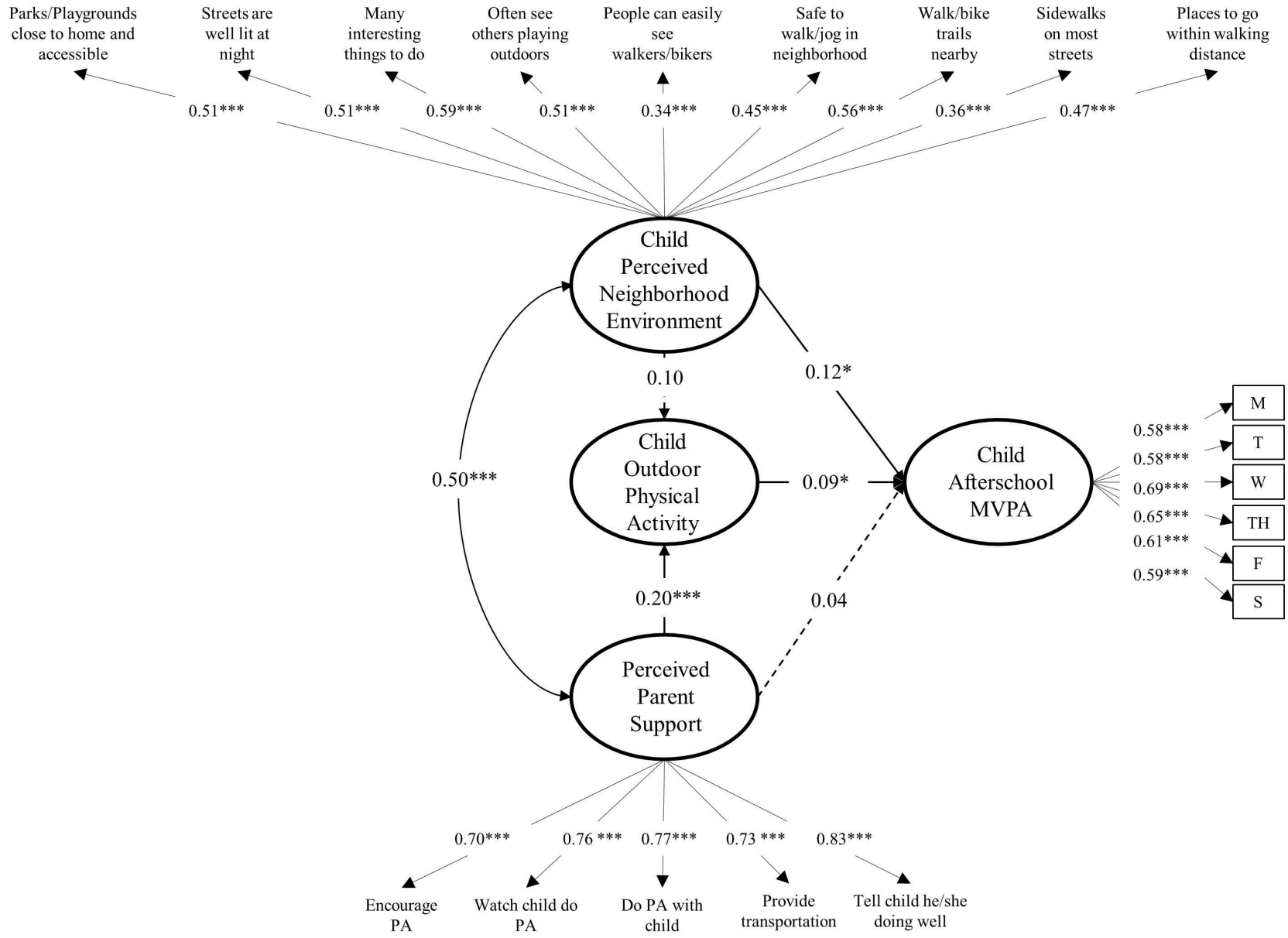

Figure 1 — Structural equation model. Illustration of the structural equation model used to test the hypothesized direct and indirect relationships between child perceptions of the neighborhood environment, child outdoor PA, perceived parent support and child afterschool moderate-to-vigorous PA, adjusted for sex, race/ethnicity, education and accelerometer wear time. The three direct hypothesized relationships included: 1) child perception of the neighborhood environment to child afterschool moderate-to-vigorous PA; 2) parent support for PA to child afterschool moderate-to-vigorous PA; and 3) child outdoor PA to child afterschool moderate-to-vigorous PA. The two indirect relationships tested included: 1) child perception of the neighborhood environment to child afterschool moderate-to-vigorous PA, mediated by child outdoor PA, and 2) parent support for PA to child afterschool moderate-to-vigorous PA, mediated by child outdoor PA. Dashed lines represent nonsignificant pathways. Indicators with their factor loadings are presented. *$p < .05$, **$p < .01$, ***$p < .0001$.

Other findings depicted by the model include significant positive associations between parent support for PA and child outdoor PA ($\beta = 0.20$; $p < .001$), a significant positive correlation between child perception of the neighborhood environment and parent support for PA ($\beta = 0.50$; $p < .001$), and a nearly significant positive relationship between child perception of the neighborhood environment and child outdoor PA ($\beta = 0.10$; $p = .075$).

Two indirect relationships were also tested in this model. The indirect relationship between child perception of the neighborhood environment and child afterschool moderate-to-vigorous PA, mediated by child outdoor PA, was not significant ($\beta = 0.010$; $p = .162$). The indirect relationship between parent support for PA and child afterschool moderate-to-vigorous PA, mediated by child outdoor PA, was nearly significant ($\beta = 0.02$; $p = .07$).

Discussion

This study examined the influence of the neighborhood environment, perceived by the parent and child, on children's afterschool moderate-to-vigorous PA. One of the major findings of this study was that the neighborhood environment, perceived by the child, was directly associated with his or her moderate-to-vigorous physical activity habits during the afterschool period. Importantly, it appears that specific neighborhood factors, including aesthetics, availability of nearby PA facilities, transportation and safety, may influence moderate-to-vigorous PA levels of 10-year old children. The discovery of these influential factors may provide some clarity within the current literature regarding this relationship in addition to potential intervention strategies for increasing moderate-to-vigorous PA among youth.

One of the unique attributes of this study was that it included established correlates of physical activity (i.e., outdoor physical activity and parent support). We found that outdoor physical activity was associated with increases in afterschool moderate-to-vigorous PA, which is consistent with previous literature (9,33). For example, Cleland et al. (9) found that children who spent more time outdoors had higher levels of moderate-to-vigorous PA. Although our study limited physical activity to afterschool hours, our results are similar; possibly suggesting that the impact of time spent outdoors may not depend on the time of day. This might indicate that increasing time outdoors during any segment of the day may increase moderate-to-vigorous PA in children.

Contrary to other studies, we did not find a significant association between child perceived neighborhood environment and outdoor physical activity (8,45). An explanation for this may be that the outdoor activities reported by the child did not occur in the child's neighborhood, but rather in another setting. In the measure used to assess child outdoor activity, the setting in which the outdoor activities took place was not considered, which may in part explain our null finding. In addition, this may also explain the lack of an indirect relationship between perceived neighborhood environment and afterschool moderate-to-vigorous PA, mediated by outdoor physical activity. As such, it may be particularly important for future researchers to consider the setting in which children participate in outdoor activities or PA in general, as recent evidence indicates that correlates of PA may, in part, depend on the setting (40,41).

Unexpectedly, our study did not find a significant relationship between perceived parent support for physical activity and afterschool moderate-to-vigorous PA. A considerable amount of evidence suggests that parent support positively influences children's physical activity (5,28,50). An explanation for this finding may be the limitations of the parent survey used in this study, as the items in this instrument specifically refer to support provided by the parent, potentially excluding children who returned home under the supervision of a sibling or grandparent during the afterschool hours. In addition, this survey would not account for children who spend time at the supervised home of a friend after school and the potential influence that their friend's parent(s) may have on their physical activity habits. This finding demonstrates the need for future researchers to use either multiple measures of support for physical activity (e.g., parent, peer) or modify current instruments to include a wider range of individuals with which a child may interact with during the afterschool hours.

Despite the nonsignificant association between parent support and afterschool moderate-to-vigorous PA, this study did find that parent support for physical activity was positively associated with outdoor physical activity. Although research regarding this relationship is limited, our results are consistent with previous research by Cleland et al. (10). Results from their work indicate that parental encouragement, a component of parental support, positively predicted time spent outdoors for girls. In addition, we found that parent support was moderately and positively associated with the perceived neighborhood environment. The exact mechanisms of this relationship are unclear; however, we speculate that children with a high level of perceived parent support, possibly demonstrated by parents who encourage them to play outdoors and/or engage in physical activity with the child outdoors (e.g., a game of catch in the yard or street), may positively influence their child's perception of their neighborhood. In addition, it is plausible that parents who perceive their neighborhood environment as safe may be more likely to encourage their children to play outdoors (54). The positive influence of parent support on their children has been previously demonstrated, albeit not in identical contexts. For example, Davison et al. (13) found that perceived parent support was positively related to perceived athletic competence (12). Similarly, Brustad et al. (6) reported that parent support for physical activity was positively associated with children's attraction to physical activity (6).

Although the evidence from previous research regarding the association of neighborhood environment perceived by the parent and their children's physical

activity is ambiguous (18), we anticipated that parent perceptions might contribute independently to the relationship between child perceptions of the neighborhood environment and their physical activity habits. The results of this study did not support that hypothesis. However, our findings indicated that parents' perceptions are highly correlated ($r = .98$) with their child's perceptions of the neighborhood environment. This is important, as it reinforces that the perceptions of the neighborhood characteristics are similar between the parent and child, which may influence the development and implementation of strategies to promote physical activity in the neighborhood environment. These findings are not surprising, given that parents have a strong influence on their children's cognitive development. For example, some evidence indicates that how a parent perceives his or her child's competencies (e.g., academic, social skills) influences how the child perceives his or her own competencies (20). Because of this, parents' perception of the environment may influence their child's perception, possibly through behavior (e.g., spending little time outdoors) or through verbal messages (e.g., "it is not safe to go outside").

To our knowledge, this was the first study to assess the association between neighborhood environment, perceived by the parent and child, and children's afterschool moderate-to-vigorous PA while including recognized correlates of PA (i.e., parent support, 50, and outdoor physical activity, 9). The strengths of our study include the use of an objective measure of physical activity (i.e., accelerometers), a large diverse sample, and the use of reliable surveys. While some of our findings were significant, some of the associations were fairly weak, and this may be attributed to our limitations. First, we employed a cross-sectional study design, which limited our ability to draw causal inferences. Second, the perceived neighborhood environment survey items failed to provide a definition of neighborhood. However, within the built environment field, a clear definition of neighborhood has yet to be determined (11). Third, the lack of information regarding the setting in the outdoor physical activity survey in addition to the weaknesses of self-reported activity (39), possibly precluded our ability to find a significant relationship between neighborhood environment and outdoor physical activity. Fourth, previous research has suggested that the influences of the neighborhood environment on PA behaviors may be different for males and females (7,45). In this study, the inability to fit the structural equation model for males and females separately resulted in the analysis of a combined model. As such, we were unable to speculate on any potential differences in the influence of the neighborhood environment on PA between males and females. Lastly, although one of the strengths of the study was the inclusion of established correlates of PA, other known correlates that may potentially influence afterschool moderate-to-vigorous PA were not included (e.g., social support, self-efficacy, etc.; 15,52).

The findings of this study demonstrate the importance of child perceptions of the neighborhood environment in relation to their moderate-to-vigorous PA behavior. In addition, our findings emphasize the critical influence of parent support on time spent outdoors and that children who allocate more time outdoors during the afterschool period achieve greater levels of moderate-to-vigorous PA. In light of these findings, we recommend that future researchers identify strategies to increase parental support for PA and outdoor time among youth, such as educating parents about nearby PA opportunities. In addition, it may be likely that parents and children who negatively perceive their environment potentially engage in lower levels of moderate-to-vigorous PA compared with families with positive perceptions; thus, we encourage future investigators to develop effective strategies to promote PA among this specific population.

In conclusion, this study emphasizes the important influence of the perceived neighborhood environment on children's moderate-to-vigorous PA habits during after school hours. Moreover, these findings strengthen the evidence in the existing literature regarding the positive association between outdoor physical activity and moderate-to-vigorous PA in addition to the important role of parent support for PA. Future studies may consider incorporating objective measures of the environment in addition to perceptions, continuing to develop a clear definition of neighborhood, and possibly including more well-established correlates of physical activity to further elucidate the relationship between the neighborhood and children's moderate-to-vigorous PA.

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