Preventive Medicine xxx (2014) xxx–xxx

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

Physical and social home environment in relation to children's overall and home-based physical activity and sedentary time

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ARTICLE INFO

Available online xxxx

Keywords:
Childhood obesity
Screen time
Basketball
Parental support
Home environment
Physical activity equipment
Electronic media

ABSTRACT

Background. Given the obesity epidemic, it is critical to understand factors associated with youth physical activity and sedentary behavior at home, where youth spend significant time. We examined relationships between these child behaviors and home environment factors.

Methods. Data were obtained from 713 children aged 6 to 11 in Washington and California 2007–2009. Multivariate regression analyses controlling for socio-demographics examined associations between parent-reported home environment factors and child's accelerometer-measured moderate-to-vigorous physical activity (MVPA) and sedentary time, overall and at home, and parent-reported child screen time.

Results. Children averaged 47.2% of time at home, which included 43.6% and 46.4% of overall MVPA and sedentary behavior, respectively. Parental support for physical activity and having a basketball hoop were positively associated with MVPA and negatively associated with sedentary behavior. Combined parental support and a basketball hoop was associated with even higher MVPA. Children with fewer bedroom media devices and more fixed play equipment had lower overall sedentary behavior and screen time than either factor alone. Findings were similar regardless of weight status.

Conclusions. Physical and social home environment variables, especially when combined, were related to more child MVPA and less sedentary behavior. Results support addressing multiple home environment factors in childhood obesity prevention.

Introduction

Preventing childhood obesity is an important goal in addressing the global obesity epidemic (Caballero, 2007). Understanding how home environments, where children spend significant time, influence children's activity behaviors could lead to evidence-based interventions (Birch and Davison, 2001; Maitland et al., 2013). Children's activity encompasses both physical activity and sedentary behavior, each of which has different associated influences and health implications (Davison and Lawson, 2006; Fairclough et al., 2009; Gebremariam et al., 2013; Marshall and Ramirez, 2011). Several physical and social environment factors at home have been identified as correlates of children's physical activity and sedentary behavior (Marcus et al., 2012; Roemmich et al., 2007; Saelens et al., 2002). An international review found that the most important, positive correlates of youth physical activity were related to social environments parents create: parents' own physical activity, their activity with youth, and their logistical support (e.g., transporting children to activities) (Verloigne et al., 2012). Additional studies confirmed associations of parent support and having family and/or friends to participate in activity with youth physical activity (Jimenez-Pavon et al., 2012). Timperio et al., 2013; Verloigne et al., 2013; McMinn et al., 2011; Dunton et al., 2012. Less is known about the physical environment factors at home, such as sports equipment, that are most supportive of youth physical activity, as studies have been inconclusive (Ferreira et al., 2007).

Abbreviations: BMI, body mass index; NIK, Neighborhood Impact on Kids Study; METs, metabolic equivalents; MVPA, moderate-to-vigorous physical activity.

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http://dx.doi.org/10.1016/j.ypmed.2014.05.019
0091-7435/

Regarding correlates of sedentary behavior, parental media rules (e.g., limits on media use) have been found to be inversely correlated with sedentary behavior in the majority of studies from around the world (Verloigne et al., 2012). Parents' sedentary time, sedentary activity with a parent, and number of TVs in the home were additional home environment correlates of youth sedentary time (Verloigne et al., 2012). Multiple studies reported that the presence of media devices in the bedroom was associated with more self-reported screen time (Granich et al., 2011; Wiecha et al., 001; Tandon et al., 2012). However, there have been inconsistent associations reported between media in the bedroom and overall sedentary time when assessed by accelerometer (Atkin et al., 2013a, 2013b; van Sluijs et al., 2010).

Research on environments and activity for children remains limited, with inconsistent results and methodological limitations, such as lack of objective measures and measures of activity in specific locations (Maitland et al., 2013). In particular, few studies have evaluated home environment variables with home-based physical activity and sedentary behavior, as compared to these outcomes overall. Though stronger associations of home environments are expected with activity behaviors at home, it is useful to determine associations with total daily activity behaviors to investigate the possibility of compensation. Though virtually all studies examined home environment variables separately, there is a reason to believe that the combination of variables will have stronger relations with activity-related behaviors (Birch and Davison, 2001; Golan, 2006). Ecological models demonstrate that health behaviors have multiple levels of influence with interactive effects across domains, including physical and social environment (Sallis et al., 2008).

The present study used objective measurements of moderate-to-vigorous physical activity (MVPA) and sedentary behavior in a large sample of children to test the following hypotheses: 1) physical environment (i.e., presence of physical activity equipment and media devices) and social environment (i.e., parent support for physical activity and rules for media use) variables are related to MVPA and sedentary behavior, both overall and at home, while controlling for demographic factors, and 2) social and environmental factors interact with each other to have additive impact on MVPA and sedentary behavior.

Methods

Participants

Participants were part of the Neighborhood Impact on Kids (NIK) Study, a longitudinal, observational cohort study of children aged 6 to 11 and their parents in Seattle/King County, Washington and San Diego County, California (Frank et al., 2012; Saelens et al., 2012). NIK was designed to evaluate the association of neighborhood and home environmental factors with children's and parents' weight status and weight-related behaviors. This study was approved by the institutional review boards at Seattle Children's Hospital and San Diego State University.

Protocol

The present analysis used baseline data collected September 2007–January 2009. Attempts were made to contact a total of 8616 households, of which 4975 were screened for interest and eligibility, and 944 agreed to participate. Among families agreeing to participate, 730 consented and were enrolled. The present study sample consisted of 713 child–parent pairs who completed the parent survey and had valid accelerometer data. Details regarding recruitment and inclusion/exclusion criteria were previously published (Saelens et al., 2012).

Parents provided consent and children provided assent at a home or clinic visit. The parent completed a survey that assessed, among other things, access to media and physical activity equipment at home, children's sedentary behaviors, household rules and practices about physical activity and sedentary behavior, and sociodemographic information. The complete NIK survey is available at: http://www.seattlechildrens.org/research/child-health-behavior-and-development/saelens-lab/measures-and-protocols.

Measures

Physical home environment was assessed by parent report using items and scales with established moderate to high test–retest reliability A Bedroom Media Score was generated by summing five items: presence of a TV, DVD/VCR, computer, video game system and/or hand held video game player in the child's bedroom (test–retest reliability ICC = .51–.96) (Joe and Carlson, 2010). A Fixed Play Equipment Score was generated by summing two items: presence of a basketball hoop and a fixed swing set (ICC = .53–.80) (Joe and Carlson, 2010). A Portable Play Equipment Score was generated by summing four items: presence of a bike, jump rope, sports equipment (balls, racquets) and/or roller skates (ICC = .60–.82) (Joe and Carlson, 2010). We also examined each scales' individual items to determine relative contributions.

Social environment was measured through three scales. The Parent Support for physical activity score summed how many days during a typical week a parent/household adult would 1) "watch child participate in sports or physical activity," 2) "encourage child to do sports or physical activity," and/or 3) "provide transport to a place where child can do physical activity or play sports" with responses of 1 = never; 2 = 1–2 days; 3 = 3–4 days; 4 = 5–6 days and 5 = daily. A cut-point of <5 and ≥5 was selected to indicate daily support on one item, or some support on more than one item, as compared to little or no support on any item. The Safety Rules Score summed "yes" responses on three rules (yes/no): "Stay close/within sight of house/parent," "do not go into street," "do not ride bike on street" (ICC = .61–.74) (Joe and Carlson, 2010). The Media Rules Score summed "yes" responses on two rules: "no TV before homework" and "<2 hours of TV per day" (ICCs = .57 and .73, respectively).

Screen time, sedentary time and physical activity

Parents reported their children's "typical weekday time" spent watching TV/DVDs, playing video games and using the Internet/other electronic media as: none, 15 min, 30 min, 1 hours, 2 hours, 3 hours, ≥4 hours per day (ICC = .66, .73, .72, respectively) (Marshall et al., 2002). Responses were summed to create a child screen time of average hours/day. Parents also reported on the frequency with which their child engaged in screen time with a parent, sibling or friends.

Child overall physical activity and sedentary behavior were measured by the GT1M Actigraph accelerometer (Pensacola, FL), which has been validated for children (Pate et al., 2006). Accelerometer data were collected in 30 second epochs. Participants were asked to wear the accelerometer for 7 days during waking hours. A valid day was ≥10 valid hours of wearing time, and a valid hour contained <20 minutes of consecutive zero counts. Data were included for children with at least 3 valid days. Valid data were converted to minutes engaged in sedentary behavior (<100 counts per minute) and MVPA (≥3 metabolic equivalents (METs) using Freedson age-specific cut-points with the participant's age rounded to half a year (Freedson et al., 1997). Overnight wear time was converted to "non-wearing time" using a previously published protocol to prevent overestimating sedentary time (Tandon et al., 2012). Accelerometer data were scored using MeterPlus version 4.0 (Santech, Inc., www.meterplussoftware.com).

Parents completed a place log to describe where their child wore the accelerometer, and time-stamped accelerometer data were matched to this log (Kneeshaw-Price et al., in press). For this study, the "Home" category included one single location for each participant, including 'front yard' and 'backyard.' "Home" excluded homes of other parent/guardians, relatives, friends, or neighbors.

Child anthropometrics

Children had their height and weight measured by a trained research assistant. Using a digital scale, weight was measured until three of four consecutive weight readings were within 0.1 kg, with the average of these readings used. Using a stadiometer, height was measured multiple times until three of four consecutive measures were within 0.5 cm, and the average was used. Child overweight was defined as BMI ≥85th percentile and child obesity as BMI ≥95th percentile for age and gender using CDC 2000 growth charts (McMinn et al., 2011).

Analysis

All analyses were conducted using STATA software version 12. The relationship between children's home physical activity and sedentary environments and their total and home-based physical activity, sedentary behavior and screen time were examined using bivariate analyses and linear regression. Separate

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models were created for five outcomes: Accelerometer-measured Daily Overall MVPA, Daily Home MVPA, Daily Overall sedentary behavior, Daily Home sedentary behavior; and parent-reported child screen time (results in Table 2). Interaction terms were tested if variables were significant on individual analyses (bedroom media * fixed play equipment, bedroom media * media rules, child age * media rules, child age * safety rules, parent support * play equipment, parent support * bedroom media, parent support * basketball hoop) and were included in final models if statistically significant (results in Table 3). All regression analyses included covariates of the child's age, gender, weight status, family income, number of children at home, and site (San Diego or King County). We examined differences in outcomes by using overweight status as an interaction term with BMI cut-points ≥85th percentile for weight and age.

Results

The average participant age was 9.2 (±1.6) years (Table 1). The sample had balanced gender and city representation, and overweight status similar to national levels (Ogden et al., 2012). Based on the 3+ MET cutpoint used for average daily MVPA, 97% of the sample met recommendations for ≥60 minutes/day. Children averaged 47.2% of their time at home, with 43.6% of overall MVPA and 46.4% of sedentary behavior occurring there. In models controlling for sociodemographic covariates, overall MVPA was positively associated with home MVPA ($\beta = 0.64$, $p < .001$) and negatively associated with home sedentary time ($\beta = -0.19$ $p < .001$). Overall sedentary time was positively associated with home sedentary time ($\beta = 0.35$ $p < .001$) and negatively associated with home MVPA ($\beta = -0.67$ $p < .001$).

Table 1
Participant characteristics ($n^* = 713$).

Child age (years), mean (SD)	9.17 (1.55)
Child gender, *N* (% female)	49%
Child weight status	
Overweight (BMI ≥85th%, <95%)	110 (15%)
Obese (BMI ≥95th%)	77 (11%)
Parent age (years), mean (SD)	41.52 (5.85)
Parent gender, *N* (% female)	86%
Parent race, *N* (%)	
White	622 (89%)
Black	16 (2%)
Asian	30 (4%)
Other	29 (4%)
Parent ethnicity: Hispanic	94 (13%)
# of children <18 at home, mean (SD)	2.39 (.89)
Annual family income	
≤$39,000	67 (9%)
$40,000 – $89,000	218 (31%)
≥$90,000	428 (60%)
Site, *N* (%)	
King County, WA	378 (53%)
San Diego County, CA	335 (47%)
Activity*	
Overall MVPA (daily min), mean (SD)	145.99 (52.22)
MVPA at home (daily min), mean (SD)	62.19 (36.45)
Overall sedentary time (daily min), mean (SD)	395.96 (69.97)
Sedentary time at home (daily min), mean (SD)	189.36 (70.05)
Screen time by parent report (daily min), mean (SD)	116.16 (81.78)
Home media environment	
Bedroom media score, mean (SD), range	1.21 (1.23), 0–5
Media rules mean (SD), range	1.49 (0.69), 0–2
Screen time with parent (days/week), mean (SD, range	2.67 (2.38), 0–7
Screen time with siblings & peers (days/week), mean (SD, range)	4.56 (3.19), 0–14
Physical activity equipment	
Portable (# of items) mean (SD), range	3.58 (0.69), 0–4
Basketball hoop mean, percentage	59%
Playset mean, percentage	61%
Active video games, percentage	49%
Home parenting environment	
Safety Rules mean (SD), range	2.14 (1.00), 0–3
Physical activity support by parents, dichotomous, <5; > = 5 mean (SD), range	0.86 (0.35), 0–1
Physical activity with parent (days/week) mean (SD), range	1.95 (1.78), 0–7

* *n* for activity data per Table 2.

Table 2 presents regression model results examining associations between physical activity and sedentary behavior and home environment variables, while controlling for all other variables in the model. The presence of a basketball hoop at/or around home was positively associated with overall MVPA (+6 minutes) and negatively with overall sedentary behavior (−10 minutes). Parental support for physical activity was positively associated with MVPA (+12 minutes) and negatively associated with sedentary behavior (−19 minutes). MVPA at home was negatively associated with the presence of active video games (−5 minutes). Family rules about safety were associated with more (+7 minutes) sedentary behavior at home, while rules about media use were negatively associated with less sedentary behavior (−8 minutes). Screen time was positively associated with bedroom media equipment (+13 minutes), screen time with peers (+6 minutes), and active video games (+17 minutes), but negatively associated with media rules (−38 minutes). More children in the home (i.e., siblings) were highly associated with more MVPA overall (+5 minutes) and at home (+11 minutes) and more sedentary time at home (+13 minutes) but less screen time (−6 minutes). When these models are run using the Evenson criteria for scoring accelerometer data, the variables that are statistically significant remain the same as with the Freedson MVPA (Trost et al., 2011).

Table 3 summarizes exploratory analyses to examine interactions among the various home environment factors. Having high physical activity support by parents and the presence of a basketball hoop was significantly associated with even higher overall and home-based MVPA compared to individual variables. We did not find a statistically significant interaction of gender with the presence of basketball hoop, although 64% of boys versus 55% of girls had access to a basketball hoop at home. Children exposed to fewer media items in their bedroom and greater access to fixed play equipment had significantly lower overall daily sedentary time, home-based sedentary time and parent-reported screen time, and these levels were lower than for either component alone. The interaction between bedroom media and rules about media was also statistically significantly associated only with home based sedentary time. Other interaction terms were not statistically significant. Overweight status as an interaction term was not associated with any of the sedentary outcomes, but it was statistically significant for the combined variable of presence of a basketball hoop and parent activity support. In this case, overweight youth were more likely to have higher physical activity levels for the combined variable, compared to the non-overweight group.

Discussion

As hypothesized, this study identified several modifiable physical and social home environment variables that were related to children's physical activity, sedentary behavior, or both. We also found that the combinations of specific physical and social environment variables led to even stronger associations. The strongest correlates of overall objectively-measured MVPA and sedentary behavior were parental support of physical activity and the presence of a basketball hoop at/or around the home. In addition, media rules set by parents were related to lower sedentary behavior. Similar to previous studies, the home environment correlates of physical activity and sedentary behavior were not simply inverses of the same factor (Jimenez-Pavon et al., 2012; Joe and Carlson, 2010). Given our finding that a large proportion of children's daily physical activity and sedentary behavior occur at home, and that home activity behaviors are highly correlated with overall daily sedentary time and MVPA, focusing efforts on modifiable home physical and social environment factors represents a promising possibility for intervention.

Parental support for physical activity by encouraging, watching, and/or providing transport to physical activity multiple days per week improved children's activity levels by approximately 12 minutes of MVPA/day, and reduced sedentary behavior by 19 minutes/day. Parental

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Table 2
Regression models examining association between physical activity and sedentary behavior (overall and at home) and home environment and sociodemographic factors among youth in Neighborhood Impact on Kids Study (NIK).

	Overall MVPA (min/day)	Home MVPA (min/day)	Sedentary Behavior (min/day)	Home sedentary behavior (min/day)	Screen time (min/day)
N	676	678	691	677	689
Home media environment					
Bedroom media score	−0.61	−0.90	2.91	−0.80	13.14**
Media rules	2.70	−0.82	−3.67	−7.97*	−37.96**
Screen time with parent	0.58	0.50	−1.57	−0.13	1.04
Screen time with siblings/peers	−0.46	−0.21	0.85	0.43	5.52**
Physical activity equipment					
Portable	−0.62	−2.15	4.20	−2.03	−4.20
Basketball hoop	6.27*	1.37	−9.65*	−4.59	4.11
Playset	2.00	4.33	−6.08	−7.76	−5.62
Active video games	−2.57	−5.36*	6.03	−2.02	17.35**
Home parenting environment					
Safety rules	−0.69	1.66	1.34	6.57*	1.16
Physical activity support by parents dichotomous, <5; > = 5	11.79**	5.32	−19.33**	−13.49	−9.43
Physical activity with parent	1.24	0.65	−2.10	−0.70	0.43
Covariates					
Gender (0 = boys, 1 = girls)	−24.17**	−10.37**	10.13*	−1.04	−2.84
Age	−22.52**	−11.98**	20.68**	11.43**	4.91**
Weight status (1 = overwt/obese)	−6.73*	−5.22*	12.42*	−0.67	23.24**
Income	1.25*	0.14	0.09	0.06	−3.84**
# of children at home	5.11**	11.23**	−4.54	12.53**	−6.48*
Site (1 = SD, 2 = KC)	2.88	3.24	−12.98**	−2.06	−5.82
Model fit (R2)					
Without covariates	0.09	0.09	0.08	0.03	0.32
With covariates	0.55	0.40	0.30	0.11	0.37

Values are unstandardized betas.
* $p < .05$.
** $p < .01$.

support for activity had a stronger effect than providing portable sports equipment. This strong relationship between parent support and child physical activity corroborates prior studies with mostly self-reported outcomes (Verloigne et al., 2012; Heitzler et al., 2006; Jimenez-Pavon et al., 2012; Timperio et al., 2013; Verloigne et al., 2013; McMinn et al., 2011. Present results also extend the possible impact of parent support for physical activity to include reduced sedentary behavior.

Like prior studies (Hinkley et al., 2010; Carlson et al., 2010; Ramirez et al., 2011 parent media rules were correlated with lower sedentary behavior; approximately eight minutes less sedentary behavior at home/day. Conversely, each increase in safety rules that could inhibit outdoor play corresponded to an increase of 7 minutes of sedentary behavior/day. These findings suggest the benefit of parents setting limits for media use, including <2 hours of screen time/day recommended by the American Academy of Pediatrics (Committee on Public Education, 2001).

The finding that presence of a basketball hoop, but not portable play equipment or playsets, was associated with both more physical activity and less sedentary behavior was somewhat surprising. Prior literature has found mixed results with fixed play equipment. For the school-age children, who may be too old to attain significant physical activity on a playground/playset, the basketball hoop may be an example of equipment which can be used individually or with a group. There is little literature on basketball hoops as an isolated variable. However, Sallis et al. (2001) found that amenities such as basketball courts/hoops in school settings, were associated with more physical activity, especially

Table 3
Exploratory analyses to test combined variables associated with physical activity and sedentary time.

	Daily overall MVPA (min)	Daily home MVPA (min)	Daily sedentary (min)	Daily home sedentary (min)	Screen time (min)
N	675	677	692	676	691
Bedroom media and fixed play interaction					
High bedroom media/high fixed play	–	–	−4.36	−12.10	4.21
Low bedroom media/low fixed play	–	–	12.83	−19.39	−10.57
Low bedroom media/high fixed play	–	–	−18.15*	−28.25**	−26.06**
Bedroom media and media rules interaction				−4.61**	
Physical activity support and hoop availability interaction					
High physical activity support/no hoop	9.64	8.39	–	–	–
Low physical activity support/+ hoop	2.24	7.10	–	–	–
High physical activity support/+ hoop	16.62**	8.75*	–	–	–
Covariates					
Gender (0 = boys, 1 = girls)	−24.10**	−10.47**	11.64*	.07	−2.28
Age	−22.48**	−12.03**	20.65**	11.59**	5.41*
Weight status (1 = ow/obese)	−6.63*	−5.36*	11.81*	.18	24.50**
Income	1.27*	0.11	−.01	−.07	−3.90**
# of children at home	5.15**	11.18**	−4.54*	12.10**	−7.62*
Site (1 = SD, 2 = KC)	2.93	3.17	−14.73*	−3.88	−11.52*

Also adjusted for variables included in Table 2.
* $p < .05$.
** $p < .01$.

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for boys. Basketball is a common activity among boys and girls in the U.S. (Kuo et al., 2009; Olvera et al., 2009), and is associated with high levels of physical activity, especially during practice (Guagliano et al., 2013). In non-American contexts, other items, such as soccer (football) goals, might represent accessible and popular sports equipment that promotes physical activity near the home. Basketball hoop availability may also be a proxy for another factor that is conducive to physical activity, such as street safety or parents who prioritize active play/sports.

The combination of high physical activity support by parents and access to a basketball hoop was associated with higher levels of MVPA than either alone, exemplifying the additive benefits of psychosocial and material support, as Sallis et al. (2001) also found in the school setting. The combination of no media in the bedroom and high parent media rules had interactive effects on reducing sedentary behavior at home. These two interactions of physical and social environment support the principle of interaction across levels in ecological models and imply that multi-level interventions may be more effective than single-level approaches (Sallis et al., 2008).

Children with fewer bedroom media items and greater fixed play equipment access had significantly lower overall and home-based sedentary behavior and screen time than children exposed to either component alone. While there were no main effects for either of these home environment factors alone on overall and home based sedentary behavior, their interaction was significant. These findings highlight the importance of simultaneously providing physical activity opportunities while creating home environments that discourage sedentary behavior. Finally, while the literature on "exergaming" has been mixed in terms of active video games actually promoting physical activity, we found that their presence was associated with less home physical activity, which is not the desired effect (Daley, 2009; Sun, 2012).

Among study limitations, the screen time outcome was by parent-report, which has been shown to correlate with actual viewing time (Anderson et al., 1985), but is still subject to social-desirability biases that may inflate relationships with parent-report of media rules. Another limitation is that parents did not report specifically on weekend screen time. Other measures obtained through the self-report survey are also potentially subject to recall and social-desirability biases. Second, we did not examine school and neighborhood level factors but other colleagues have studied those data (Saelens et al., 2012; Kneeshaw-Price et al., 2013). Third, our sample had relatively high proportions of white and high income participants, potentially limiting the generalizability of our findings. However, the sample was somewhat comparable to the counties in our study: the 2008 median annual family income was $87903 in Seattle/King County and $74,593 in San Diego County (U.S. Census Bureau: State and County QuickFacts, 2010). Fourth, we did not examine seasonality, which could potentially influence outdoor time and other factors related to activity levels. Fifth, as a cross-sectional study, we could not evaluate causality. Sixth, there are multiple scoring decisions and cut-points for accelerometer data in children (e.g. 3 METs vs. 4 METs for moderate activity), making comparisons between studies difficult (Guinhouya et al., 2006). However, there is no clear consensus in accelerometer methods (Cain et al., 2013) and we did examine both Freedson and Evenson cutpoints with similar results. We chose the 3 MET cut-point because this is specified in the US physical activity guidelines (U.S. Department of Health and Human Services, 2008).

How to design interventions to improve children's physical activity and sedentary behavior remains a challenge. Systematic reviews of controlled trial interventions targeting home environments have found relative lack of effect overall, albeit very few studies have been done (van Sluijs et al., 2007). Systematic review of mediators of children's physical activity suggests that while many intervention studies have addressed cognitive/psychological mediators, few studies have sought to impact broader factors such as social environment, and none have measured mediating effects of physical home environment factors (Brown et al., 2013). Given the associations we found between parenting and physical environment variables and physical activity and sedentary behavior, we support the need to better address these factors in interventions. Childhood obesity and the related behaviors are multifactorial in etiology (Koplan, 2005). Therefore, interventions that utilize a multi-factor, multi-level approach focusing on both psychosocial and physical environment factors that influence physical activity and sedentary behavior hold more promise for success.

Conflict of interest statement

The authors declare that there are no conflicts of interest.

Acknowledgments

We are grateful to Dr. Trina Colburn for her assistance and support throughout the project. We thank Stephanie Kneeshaw-Price for her work on the categorization of accelerometer data by place logs. We also thank the NIK staff and study participants. This project was supported by grants from NIH (ES014240 and UL1RR025014, and Dr. Grow's time under K23DK081734).

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Please cite this article as: Tandon, P., et al., Physical and social home environment in relation to children's overall and home-based physical activity and sedentary time, Prev. Med. (2014), http://dx.doi.org/10.1016/j.ypmed.2014.05.019

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Please cite this article as: Tandon, P., et al., Physical and social home environment in relation to children's overall and home-based physical activity and sedentary time, Prev. Med. (2014), http://dx.doi.org/10.1016/j.ypmed.2014.05.019