Three-Year Changes in Low-Income Children's Physical Activity: Prospective Influence of Neighborhood Environment and Parent Supportive Behavior

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Objectives To prospectively evaluate parent supportive behaviors (PSB) for child physical activity (PA) and neighborhood environment variables on changes in child PA over 3 years.

Study design Secondary data analysis of the Now Everybody Together for Amazing and Healthful Kids-Works study with 534 parent-child (age 2-4 years) dyads randomized to a community-based pediatric obesity prevention intervention for 3 years (92% retention). PSB and neighborhood environmental variables were examined in relation to changes in child moderate-to-vigorous PA (MVPA), light and sedentary activity, and screen time. Child and parent accelerometry data were collected at visit 0, 12, 24, and 36 months. Mixed multivariate models were used to examine independent and interactive effects of parent-level and neighborhood-level variables on changes in child PA outcomes.

Results PSB significantly interacted with visit on change in child MVPA (β = 0.12) and sedentary behaviors (β = -0.18). Over 3 years, a 1-unit increase in PSB was associated with an average increase of 4.3 minutes/day of MVPA and an average decrease of 6.5 minutes/day of sedentary time. Significant main effects were observed for PSB and 3-year change in child screen time (β = -0.05). The children of parents with higher PSB at baseline watched an average of 1.8 fewer minutes/day of screen time compared with parents with lower baseline PSB. Neighborhood-level variables were not significantly associated with changes in child PA outcomes.

Conclusions Parents who increase their supportive behaviors for their child's PA have children who are more physically active and less sedentary over time. Interventions to increase preschool-age children's PA may enhance their effectiveness by targeting parents' supportive behaviors for their child's PA. *(J Pediatr: X 2021;6:100066)*.

Physical activity (PA) in children can promote a healthy body weight and reduce cardiometabolic risk factors.[1–7] However, 46% of preschool-age children do not meet the recommendations for daily 60 minutes of moderate-to-vigorous PA (MVPA).[8] Children from low income households show larger declines in PA compared with higher income children during the transition into adolescence,[9] and this reflects a broader pattern of health disparities by socioeconomic status.[9–17]

In a social determinants of health framework, the neighborhood environment and parent supportive behaviors (PSB) for child PA are potential important influences on developmental trajectories of PA in children from low income households.[18–24] "Neighborhood environment" is a complex, multidimensional construct[22,25–28] that may include physical features, such as proximity to playgrounds, parks, and green spaces, the presence of retail food outlets, as well as socioeconomic characteristics such as neighborhood poverty, safety dimensions such as traffic or crime danger (objective or perceived), and unemployment rates. Previous research on the neighborhood environment and child PA generally focused on crime and traffic safety[22,26] and economic variables.[29–31] However, new measures of the environment have been developed to capture the broader social determinants of health constructs that include neighborhood-level social, educational, economic, and health environmental components.[32–34]

BMI	Body mass index
COI	Child opportunity index
MVPA	Moderate-to-vigorous PA
NET	Now Everybody Together for Amazing and Healthful Kids
PA	Physical activity
PSB	Parent supportive behaviors

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In theory, parent behaviors that support child PA could overcome or mitigate neighborhood limitations that otherwise might inhibit child PA. PSB include modeling PA, such as doing PA with their child, and coordinating PA logistics, such as taking the child to places for PA. Both PSB—modeling and coordinating PA for children—are consistently associated cross-sectionally with higher child PA.[35–47] Parent decisions about where and when preschool-age children can be physically active may or may not be bounded by the neighborhood environment, including parent perceptions of neighborhood safety, walkability, and availability and quality of recreational opportunities.[26,28,29,35–38,40–50]

Solutions to promote low-income preschool-age children's PA can be strengthened by better understanding how parent-level and neighborhood-level variables interact or independently contribute.[26,29,35–40] The present longitudinal study examines the influence of neighborhood environment and PSB on changes in child PA over a 3-year period. The study is a secondary data analysis from the Now Everybody Together for Amazing and Healthful Kids (NET)-Works randomized controlled trial (2010-2018).[51] It was hypothesized that neighborhood environment and PSB would independently influence changes in child PA over a 3-year period. In addition, PSB were hypothesized to interact with neighborhood variables, such that adverse neighborhood environments would have a negative impact on children's decline in PA only when PSB were low.

Methods

The NET-Works study (2012-2010) was a 3-year, parent-targeted, multilevel community-based childhood obesity prevention intervention.[51] Over an 18-month period, 534 low-income, racially/ethnically diverse parent-child dyads were recruited through 14 primary care clinics in the Minneapolis-St Paul metro area. Home measurement visits were completed across all seasons at baseline (prior to randomization), 12, 24, and 36 months. Parent-child dyads were randomized to a multilevel, parent-targeted obesity prevention intervention or to a usual-care comparison group. Intervention components included home visiting, community parenting classes, and linkages to neighborhood PA and food resources through the home visiting and parenting class components. More details about the intervention are reported elsewhere.[51] Cohort retention in the parent study was 92% at 36 months. This study was reviewed and approved by the University of Minnesota IRB. All parents consented to participate.

This research used the following measures from the NET-Works parent study: (1) neighborhood environment variables that include an objective composite index summarizing neighborhood socioeconomic, health, environmental, and educational resources, and a set of parent-reported neighborhood safety variables; (2) parent behavior variables, including PSB (self-report) and parent PA (accelerometry); and (3) child PA (accelerometry). NET-Works data were collected in participants' homes by trained research staff at baseline, 12, 24, and 36 months.

Child Opportunity Index

The childhood opportunity index (COI)[32] was used in the parent study NET-Works to capture several constructs of neighborhood influences that might be most relevant for preschool-age to elementary-school-age children from low-income families. Home addresses from NET-Works families at baseline were geocoded and linked to neighborhood assessments of child opportunity and disadvantage at the level of the census tracts to create the COI (www.diversitydatakids.org).[32] Drawing from the social determinants of health field, neighborhood-level social and economic, education, and health and environment indicators were constructed from several neighborhood-level indicators of these constructs. The COI is a composite measure of items derived from census data for specific zip codes and includes neigh borhood-level indicators of educational, economic, social, and health opportunities.[32] Example variables for each of the 3 subareas include (1) social and economic opportunity (neighborhood foreclosure rate, poverty rate, unemployment rate, public assistance rate, proximity to employment); (2) health and environmental opportunity (retail healthy food availability, proximity to toxic waste release sites, volume of nearby toxic release, proximity to parks and open spaces, housing vacancy rates, proximity to health care facilities); and (3) educational opportunity (adult educational attainment, student school poverty rate, reading proficiency rate, math proficiency rate, early childhood education neighborhood participation patterns, high school graduate rate, proximity to high quality [accredited] early childhood education centers, proximity to early childhood education centers of any type), where lower index scores reflect worse neighborhood conditions. The census data derived measures are converted to z scores to capture neighborhood level position on the variables. The composite Cronbach alpha coefficient was .91[33] Categories were used in this analysis to compare neighborhoods with very low/low opportunity and moderate/high opportunity.[32–34]

Perceived Neighborhood Safety (Parent-Reported)

Parents reported the extent to which they agreed or disagreed with each of the following statements about traffic density, road safety, and walking safety in their neighborhood[48,49]: (1) "There is heavy traffic in our local streets"; (2) "There are no lights/street crossings for us to use"; (3) "We have to cross several streets to get to play areas"; (4) "It is safe to walk in the neighborhood"; (5) "Our neighborhood is safe from crime." Response options were strongly agree; agree; neither; disagree; and strongly disagree.

Parent behavior variables were selected based on the theoretical model for the NET-Works parent study,[21] and from the empirical literature on parent variables associated with child PA.[35,37–51] Parent supportive behaviors specifically related to

child PA include role modeling and logistic behaviors such as verbal encouragement, watching their child play, playing with their child, taking the child to places for play, such as parks and playgrounds.[36] The questions were (1) "During the past week how often have you encouraged this child to be active or actively play?"; (2) "During the past week how often have you done a physical activity or actively played with this child?"; (3) "During the past week how often have you taken this child to a place where he/she can do physical activities or active play?'; (4) "During the past week how often have you watched this child take part in physical activities or active play outside the home?". Response options were never; once; sometimes; almost daily; and daily.

Three additional parent supportive behaviors questions were asked: (1) "Do you limit active play indoors?"; (2) "Do you limit outdoor play in your yard?"; and (3) "Do you limit outdoor play in the neighborhood?". Response options were all of the time; most of the time; some of the time; and rarely.

Parent reported enjoyment of PA was also measured with a Likert-scale response format (ie, not at all; a little; neutral; somewhat; a lot).

Local park use with their child was measured by asking the parent to report the frequency with which they visited with their child each specific park or playground within a 1-mile radius around their home as shown to them on a tailored home-specific map.[36,51]

Child media use was measured with 3 questions reported by the parent: (1) "On an average weekday, how many hours does <this child> watch TV?"; (2) "On an average weekend day, how many hours does <this child> watch TV?"; (3) "On an average day, how many hours does <this child> play video or computer games, or use a computer for something that is not school work? (Include activities such as Play Station, Xbox, hand held video games, computer games, and the Internet.)." The weekday and weekend TV viewing hours were weighted (×5 for weekday and ×2 for weekend day) and summed with the average hours per day of small screen/video game use.[51]

PA was measured at baseline, 12, 24, and 36 months in both the parent and the child in each enrolled household using a commercially available ActiGraph GT3X+. ActiGraph monitors have been used in numerous studies to assess PA in children.[45–47,50,52–55] The validity of the ActiGraph has been examined in several studies involving children age 2-18 years.[53–59] The index children and parent in the study wore the GT3X+ monitor on the right hip for 7 complete days. The monitoring period included 2 weekend days and 5 weekdays. The valid wear time criteria (minimums) were 4 days (3 weekdays and 1 weekend day) of at least 6 hours of awake time per day with 33% nonzero epochs per hour. Accelerometry data were used to create minutes of sedentary activity, light activity, and moderate and vigorous PA, using child-specific and adult-specific cutpoints.[8,60] Minutes per day, standardized to a 12-hour wear-time day, were computed for sedentary activity, light activity, and moderate/vigorous PA.

Demographic variables were self-reported by the participating parent and included child age, sex, race, ethnicity, parent age, sex, race, ethnicity, employment status, household income, and education. Parent and child height and weight were measured with the participant in light clothing without shoes according to a standardized protocol. Weight was measured to the nearest kilogram and height was measured to the nearest 0.1 centimeter. Measures were conducted in duplicate and averaged. Body mass index (BMI) was computed as weight in kilograms divided by the square of height in meters.

Statistical Analyses

Analyses were conducted using SAS v 4.0 (SAS Institute) and R version 3.6.2 (R Core Team, 2019). Mixed model regression was used to examine associations between each of the baseline neighborhood variables, mean and change over time in parent supportive behaviors, and mean and change over 36 months in child PA. Separate models were fit for each of the following dependent variables: change in child MVPA, light activity, sedentary activity, and screen time. Change was examined using the statistical framework of mixed effects models. In the present study, preliminary models were tested with both the fixed effects and the random effects for each of the regression coefficients – the intercept, and the slope terms (for the time variable and the other time-varying covariates). None of the random effects for the time variable and the other time-varying covariates were found to be statistically significant, and thus, were removed from the models. The only random effect that was modeled was for the intercept term. The time predictor and the other time-varying covariates were only allowed to have the fixed-effect.

Potential covariates were selected for inclusion based on a priori knowledge of the literature about demographic differences in child physical activity. Child age, sex, and BMI, and parent education, marital status, and household income, and treatment group assignment, were included in each model as covariates.

Forward model selection was used to determine which neighborhood and parent supportive variables were included in the model. The variables that were significant in individual models were included in a multivariate model with their interaction terms with the time variable to examine their independent and potentially interactive effect on changes in child PA outcomes. Significance was evaluated as the variables showing a nonzero effect with a 95% CI. The variables examined in individual models included the following: parent baseline PA (MVPA, light, and sedentary, for each of those specific child PA outcomes, respectively); parent supportive behaviors (mean of 4 items); parent enjoyment of PA (single Likert-scale item); parent frequency (past month) of taking child to a local park within 1-mile radius of home (visual map-based parks around home); parent perceived neighborhood traffic safety; parent perceived neighborhood safety from crime; parent perceived safe to walk in neighborhood; and the COI (composite-based categorical variable).

Table I. Parent, child, and neighborhood environment variables at baseline in the NET-Works Study (N = 534 dyads)

Household variables	% (N)	Mean (SD)[range]
Household income (annual; $)		
1 <$15 000	37.6 (201)	
2 $15 000-$24 999	25.3 (135)	
3 $25 000+	37.1 (198)	
Household education		
1 <High school	33.3 (178)	
2 High school Diploma	22.1 (118)	
3 Some college/technical	25.7 (137)	
4 Bachelor's degree or more	18.9 (101)	
Marital status		
Married	68.7 (367)	
Not married	31.3 (167)	
Employment status		
Full time	29.8 (159)	
Part time	27.7 (148)	
Not working for pay	42.5 (227)	
Child variables		
Age (y)		3.4 (0.65) [2.1- 4.3]
Hispanic ethnicity		
Yes	58.4 (312)	
No	41.6 (222)	
Race/ethnicity		
Non-Hispanic White	12.5 (67)	
Non-Hispanic Black	18.4 (98)	
Hispanic	58.4 (312)	
Multiracial	8.4 (45)	
Other	2.2 (12)	
Sex		
Female	50.9 (272)	
Male	49.1 (262)	
BMI kg/m^2		17.6 (1.8) [15.3-27.7]
BMI percentile		81.7 (14.3) [50.3-99.9]
Child PA (accelerometry)		
MVPA standardized min/d	78.5 (24.0)	
Sedentary PA standardized min/d	428.4 (46.1)	
Light PA standardized min/d	213.1 (31.6)	
Media/screen time (h/d)	2.8 (1.7)	
Parent variables		
Age (y)		31.9 (6.4) [17.1-67.2]
Sex (female)	91.7 (486)	
BMI kg/m^2		30.1 (7.0) [17.2-69.4]
Parent PA (accelerometry)		
MVPA standardized min/d	15.5 (14.4)	
Sedentary PA standardized min/d	441.9 (68.3)	
Light PA standardized	262.6 (62.5)	
Parent supportive behaviors for child PA* (mean of 4 items) 4 = daily; 3 = almost daily 2 = sometimes; 1 = once; 0 = never	2.5 (.82)	
0-1.75	22.1 (118)	
2-2.33	24.2 (129)	
2.5-2.75	23.7 (125)	
3-4	30.0 (162)	
Parent enjoyment of PA		
Not at all	3.4 (18)	
A little	12.6 (67)	
Neutral	11.6 (62)	
Somewhat	29.4 (157)	
A lot	43.1 (230)	

(*continued*)

Table I. Continued

Household variables	% (N)	Mean (SD)[range]
Local park use with children (past mo) (map around home)		3.5 (6.6) [0-50]
0	50.9 (268)	
1-2	15.3 (81)	
3-5	14.1 (74)	
6-50	19.7 (104)	

Neighborhood environment variables*

COI composites	Social/ economic	Health/ environment	Education
Very low	11	22	56
Low	39	151	218
Moderate	75	222	170
High	214	119	75
Very high	186	11	6
Perceived neighborhood safety: traffic safety†			10.0 (2.8) [3-15]
Neighborhood is safe from crime			
1 strongly agree	15.6 (82)		
2 agree	39.3 (207)		
3 neither	13.5 (71)		
4 disagree	23.7 (125)		
5 strongly disagree	8.0 (42)		
Safe to walk in neighborhood			
1 strongly agree	24.2 (128)		
2 agree	52.0 (275)		
3 neither	7.8 (41)		
4 disagree	10.2 (54)		
5 strongly disagree	5.9 (31)		

*Parent supportive behaviors: During the past week, how often have you encouraged this child to be active or actively play? How often have you done a physical activity or actively played with your child? How often have you taken this child to a place where s/he can do physical activity or active play? Have you watched this child take part in physical activities or active play outside the home?

†Traffic safety: there is heavy traffic in our local streets; there are no lights/street crossings for us to use; we have to cross several streets to get to play areas (sum 3 items) 1 = strongly disagree; 5 = strongly agree.

The COI has been used as a composite index in previous research. Thus, a priori, the decision was made to use the scale as a categorical composite. In exploratory post-hoc analyses, each of the 3 subindices were examined in multivariate analyses (social/economic; health/environment; education). The reason for this exploratory analysis was to determine whether, in this sample, and for these specific neighborhoods, there might be certain social or economic neighborhood variables that are particularly relevant for PA changes among these young children from racially/ethnically diverse low-income families.

The PA outcome variables had an average of 14.6% missing data across the follow up time points (12, 24, and 36 months; complete PA data were available at baseline on 534 children). The media use variable had an average of 8.6% missing data. The data for all variables were tested for the missing data mechanism and were determined to be missing at random. The missing values were then imputed using the MissMech package in R.[61] The imputation was performed using key demographic variables: treatment group,

Table II. Neighborhood environment and PSB for child PA: predictors of 3-year change in child PA and screen time

MVPA (standardized min/d)		
Variables	**Estimate (SE)**	**95% CI**
Intercept	107.64 (7.61)	92.72, 122.56
Visit*	**−0.25 (.10)**	**−0.45, -0.05**
Treatment	0.066 (1.98)	−3.81, 3.94
Visit* treatment	0.010 (0.06)	−0.11, 0.13
Age (y)	−1.68 (1.32)	−4.28, 0.91
Sex (ref: boys)	**−11.62 (1.71)**	**−15.00, -8.28**
Hispanic (yes)	−0.54 (2.04)	−4.55, 3.46
BMI (kg/m^2)	**−0.67 (.30)**	**−1.26, -0.07**
Parent MVPA (baseline)	**0.10 (.04)**	**0.02, 0.17**
Parent limit play indoors (baseline)	**−1.61 (.54)**	**−2.66, -0.56**
PSB × visit	**0.12 (.04)**	**0.05, 0.20**
Neighborhood COI (ref: high)	−2.44 (2.00)	−6.35, 1.47
Light PA		
Variables	**Estimate (SE)**	**95% CI**
Intercept	189.70 (9.79)	170.50, 208.89
Visit	0.04 (.06)	−0.07, 0.16
Treatment	5.05 (2.51)	0.14, 9.96
Visit* treatment	−0.11 (0.09)	−0.28, 0.06
Age (y)	−1.12 (1.58)	−4.20, 1.98
Sex (ref: boys)	**5.21 (2.05)**	**1.19, 9.23**
Hispanic (yes)	**5.98 (2.48)**	**1.13, 10.84**
BMI (kg/m^2)	0.35 (0.39)	−0.41, 1.10
Parent light PA (baseline)	**0.03 (.01)**	**0.01, 0.06**
Neighborhood COI (ref: high)	0.41 (2.38)	−4.24, 5.08
Sedentary activity		
Variables	**Estimate (SE)**	**95% CI**
Intercept	392.78 (17.30)	358.86, 426.69
Visit	0.32 (0.23)	−0.13, 0.76
Treatment	−5.00 (3.81)	−12.48, 2.48
Visit* treatment	0.13 (0.14)	−0.15, 0.40
Age (y)	1.50 (2.42)	−3.23, 6.24
Sex (ref: boys)	4.78 (3.14)	−1.38, 10.93
Hispanic (yes)	−4.34 (3.83)	−11.85, 3.17
BMI (kg/m^2)	0.22 (0.60)	−0.96, 1.41
Parent sedentary behavior (baseline)	**0.05 (.02)**	**0.02, 0.09**
PSB × visit	**−0.18 (.09)**	**−0.35, -0.01**
Neighborhood COI (ref: high)	0.84 (3.64)	−6.30, 7.98
Screen time		
Variables	**Estimate (SE)**	**95% CI**
Intercept	1.77 (0.16)	1.46, 2.09
Visit	−0.001 (.001)	−0.003, 0.000
Treatment	−0.03 (0.04)	−0.11, 0.04
Visit* treatment	−0.003 (0.001)	−0.01, 0.00
Age (y)	**0.07 (.03)**	**0.02, 0.13**
Sex (ref: boys)	**−0.13 (.04)**	**−0.20, -0.07**
Hispanic (yes)	**−0.08 (.04)**	**−0.16, -0.002**
BMI (kg/m^2)	−0.003 (0.01)	−0.02, 0.01
PSB (baseline)	**−0.05 (.02)**	**−0.08, -0.02**
Neighborhood COI (ref: high)	−0.06 (.04)	−0.14, 0.02

Bolded areas highlight significant variables.
Household income, parent education, and marital status are nonsignificant covariates in all models and are not shown.
*Visit is baseline, 12, 24, and 36 months.

child age, child sex, child BMI, baseline outcome variable, race, highest household education, and annual household income. A sensitivity analysis was performed which showed that the imputed data were not significantly different from the original data based on a 2-sample t test [t (404) = -1.15, P = .25].

Results

Demographic variables, neighborhood, and parent supportive behavior variables at baseline are shown in Table I; 37% of parents reported a household income of less than $15 000 per year, 55% had completed high school or less education, 62% of parents reported that they were not born in the US, 68% were married, and 56% were working for pay full or part time; 58% of children were of Hispanic ethnicity. The average BMI percentile for age and sex was 81.7 (SD = 14.3). PSB were evenly distributed across the response categories (from lower to higher levels of support). Parent perceptions of the neighborhood environment were generally positive across all of the items queried. Perception of crime was low and parents felt safe walking in the neighborhood. The frequency of parent-reported use of parks and green spaces within 1 mile of their home was low (over one-half reported no use) and 74% of families lived in neighborhoods with low or very low child opportunities.

The results of the mixed effects model for change in child MVPA are shown in Table II (top). In this model, PSB showed a significant interaction effect with visit (β = 0.12). This indicates that parents with a one-point higher PSB score have children who increase their MVPA by 4.3 minutes/day over 3 years. Figure 1 shows the pattern of change in MVPA over time by PSB level. Parents who increased their PSB over time (red line) had children whose MPVA minutes per day increased the most over the 3-year period (maximum child MVPA increase at 24 months). These results also show that the baseline effect was nonsignificant. This indicates that the overall level of the parents' supportive behaviors was less impactful than the sustained increase in the level of PSB over the 3-year period.

In addition to PSB, significant main effects were observed for the variables parent MVPA and parent limiting the child's indoor play. Parents who were more active at baseline had children who were more active on average over the 3-year period. Parents who limited indoor play at baseline had children who were less active on average over the 3-year period. In addition, results showed that the average level of MVPA was higher among boys and lower among children with higher BMI. None of the neighborhood environment variables were significantly associated with changes in child MVPA.

The results from the analysis of the change in light PA show no significant interaction effects between any variables and visit (Table II). The significant main effects are as

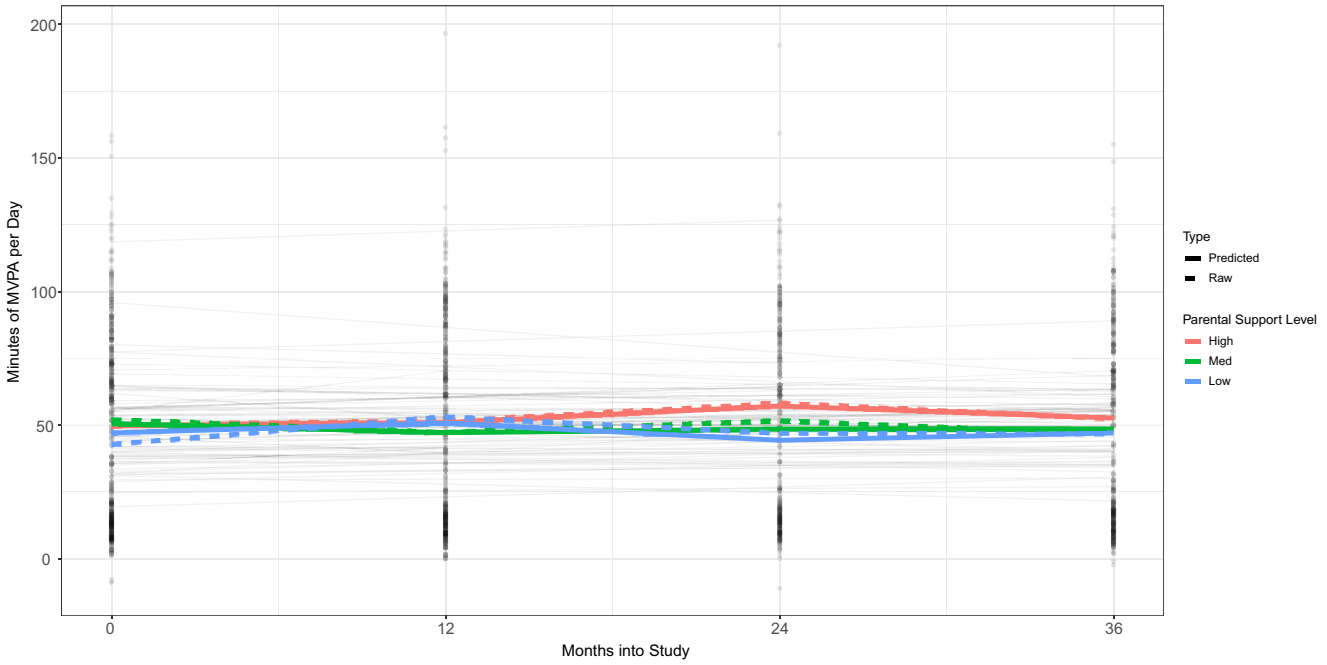

Figure 1. Changes over 3 years in low-income preschool-age children's MVPA by PSB. (PSB less than 2 = "low" and PSB above 2.75 = "high" based on the quantiles of the data).

follows: children with parents with more frequent light activity (β = 0.03); female children (β = 5.09); and children of Hispanic ethnicity (β = 5.95) had more minutes per day of light activity over 3 years compared with parents with less frequent light activity, male children, or children of non-Hispanic ethnicity. None of the neighborhood environment variables were significantly associated with changes in child light PA.

The results from the analysis of the change in sedentary activity show a significant interaction effect between PSB and visit (β = -0.18) (**Table II** and **Figure 2**). This indicates that as parents increased their supportive behaviors over time, child sedentary activity decreased by an average of -6.5 minutes/day over 3 years. **Figure 2** shows that parents whose PSB increased over time had children whose sedentary activity decreased over time (maximum decrease at 24 months). Significant main effects were observed for parent sedentary activity (β = 0.04; parents with more sedentary activity at baseline had children with on average more minutes of sedentary activity per day over the 3-year period). None of the neighborhood environment variables were significantly associated with changes in child sedentary PA.

The media use outcome model did not show significant interaction effects for any of the variables with visit (**Table II**). However, significant main effects were observed for PSB (β = -0.05; parents with higher PSB had children with on average -1.8 fewer minutes per day of media use over 3 years); child age (β = 0.07; older children at baseline had on average more minutes per day of use); and sex (β = -0.13) (boys had on average more minutes per day of media use than girls over the 3-year period). None of the neighborhood environment variables were significantly associated with changes in child media use.

Post-hoc exploratory analyses were conducted to explore the possibility that certain subscales of the COI might be significant predictors of changes in child PA. In these exploratory analyses, we reran the models a second time, including the 3 COI subscales in place of the single composite index. Results showed that only the social/economic subscale was significantly associated with change in child MVPA, sedentary time, and screen time. The direction of association was opposite to expected for MVPA and sedentary time. Higher social/economic neighborhood opportunity was associated with lower overall MVPA, and higher sedentary time. Associations were in the expected direction for media use/screen time, with higher neighborhood opportunity associated with less media use/screen time.

Discussion

Among this sample of lower income, racially/ethnically diverse families, parents who over 3 years increased their supportive behaviors (eg, role modeling, logistic behaviors) for their child's PA had children who significantly increased their MVPA and decreased sedentary activity over 3 years. Although the absolute change in child PA and sedentary behaviors was small from an individual-level or clinical perspective, the magnitude of change is important from a population-level perspective.[62,63] In addition, children of parents with higher supportive PA behaviors at baseline significantly decreased their television/small screen use time over 3 years. Parents' own MVPA and light PA at baseline

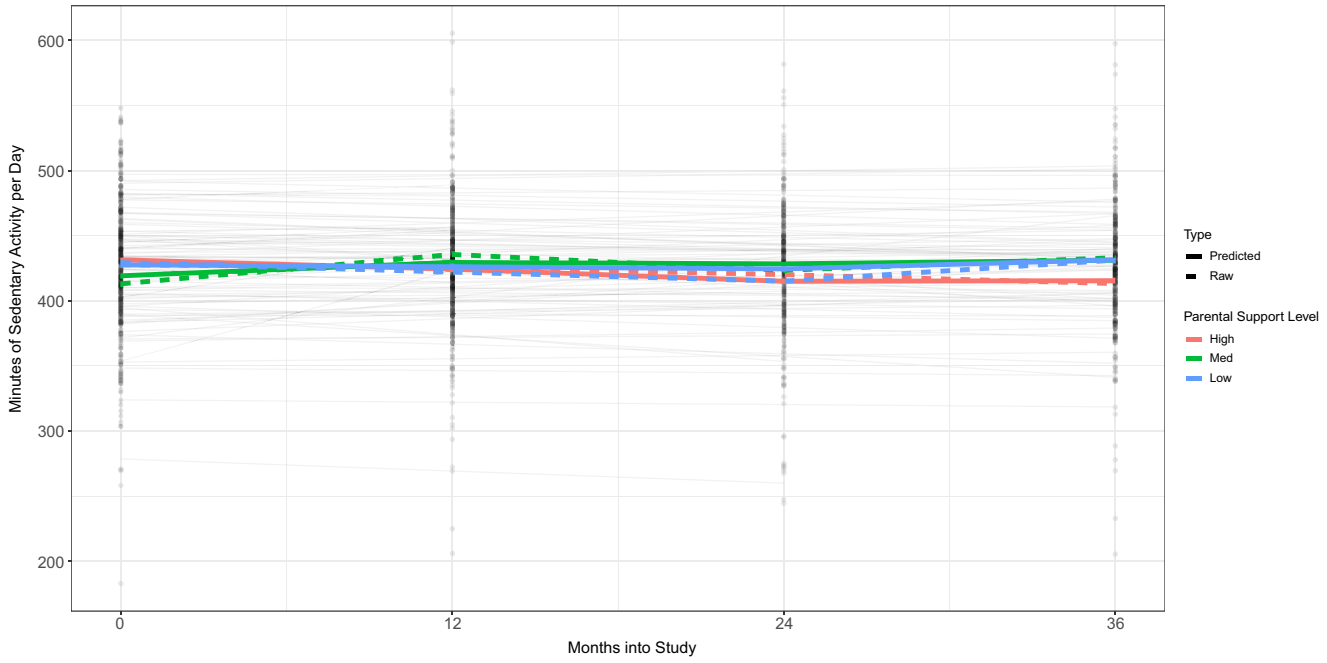

Figure 2. Changes over 3 years in low-income preschool-age children's sedentary activity by PSB. (PSB less than 2 = "low" and PSB above 2.75 = "high" based on the quantiles of the data).

significantly positively predicted average levels over 3 years of their child's MVPA and light PA, respectively. These results are consistent with the 2 available longitudinal studies that showed that parent supportive behaviors were associated with either an increase or less decrease in child PA over time.[49,50] Parent perceptions of neighborhood safety were not significantly associated with changes in child PA over 3 years. Interestingly, neighborhood-level variables captured by the COI, such as poverty, educational level, crime, walkability, or presence of parks or food retail outlets, were not significantly associated with changes in child PA over 3 years in models that included parent- and home-level variables.

These results suggest that modifiable parent behaviors that support child PA can significantly improve child PA levels over time. Regardless of certain types of neighborhood features or resources, low-income parents can play an effective role in increasing their child's PA levels over time. Encouraging their child to play and be active, engaging in PA with their child, taking their child to places to be physically active, and praising their child for being physically active are behaviors parents can engage in to support their child's PA. Parent concerns about neighborhood crime and traffic safety and objective social, physical, and economic neighborhood characteristics seem to be less significant barriers to child increases in PA in the context of positive supportive parenting behaviors for child PA. The children in the present study were pre-school-age, and so the parents may have greater influence and control over when, where, and how their child engages in PA and play, compared with parents of school-age children. The Minneapolis metropolitan area has many local parks and green spaces, and most parents reported feeling safe in their neighborhoods. Thus, the present findings may not hold for parents who live in neighborhoods they perceive as unsafe.

Research and theories related to health equity have identified a wide range of social, economic, and physical environmental variables that affect health outcomes. The COI can be viewed as a broad neighborhood environmental measure of the constructs related to health equity, and it includes social, educational, and health-related constructs. The subscale composites represent distal environmental influences on health outcomes, compared with similar variables measured at the individual household level. For example, the social and economic opportunity subscale indicator variables include the neighborhood percentage of people with incomes below poverty. The neighborhood poverty level and the individual household income variable each may have independent associations with child health behaviors like PA. However, a child's individual household income is a more proximal variable than neighborhood poverty level, and, thus, might be expected to have a stronger influence on child PA behaviors. Most previous research has not included both neighborhood-level and individual-household-level measures of similar constructs, so often it has not been possible to simultaneously evaluate the effects of distal and proximal variables.

For the present analysis, it was recognized that the neighborhood environment is an important determinant of health outcomes. The COI represented an available, multidimensional measure of the wide-ranging factors at the neighborhood level that might be important to examine

in relationship to child health behavior outcomes. We had no a priori hypothesis about which specific social determinants of health constructs might predict changes in child health behaviors, over and above similar variables that were measured at the individual household level. Therefore, we chose to use the composite COI a priori to be consistent with the existing research literature and because few data were available to guide an a priori selection of social determinants constructs in relation to child PA. In addition, we had parent reported perceptions of the neighborhood built environment and parent reported frequency of use with their child of parks near their home.

The present study had several strengths and some limitations. Strengths included a diverse, low-income sample with a high retention rate over 3 years, accelerometry PA measures in children and their parent, several measures of different parent supportive behaviors, and both perceived and objective aspects of the neighborhood environment. The multilevel nature of the data and the questions addressed is also a strength. Limitations include lack of specific data on seasonality and use of the built environment, and community-based PA resources. The study was conducted in a geographic location that experiences extremely cold and long winter weather. Families were enrolled in the study for 3 years, and, thus, all seasons were captured regarding the key predictor and outcome variables. However, because of the severe winter weather, it would be desirable to examine the variability in levels and types of parent supportive behaviors and use of the community PA resources across different seasons. The COI measure of the neighborhood environment has strengths and limitations, and the research on the more distal social determinants of child PA warrants exploration with both broad measures such as the COI and with neighborhood measures that are more specific to child PA. Another limitation of the study that is shared by many studies in the behavioral sciences is the use of a Likert-scale metric for the PSB score. PSB is measured using categorical response options and it is unclear how much change an increase or decrease in one unit represents. Therefore, it is difficult to quantify the amount of change in PSB that produces a given number of minutes of change in child MVPA or sedentary behavior. This limitation is inherent in measures that use Likert-type response options to capture the frequency of self-reported behaviors.

Parents who increase their supportive behaviors for their child's PA have children who are more physically active and less sedentary over time. Community-based interventions to increase preschool-age children's PA may enhance their effectiveness by targeting parents' supportive behaviors for their child's PA. ■

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