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Home food environment in relation to children's diet quality and weight status

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Abstract

The objective of this cohort study was to explore relationships between the home food environment (HFE), child / parent characteristics, diet quality and measured weight status among 699 child-parent pairs from King County, WA and San Diego County, CA. HFE variables included parenting style / feeding practices, food rules, frequency of eating out, home food availability, and parent's perception of food costs. Child dietary intake was measured by 3 day recall and diet quality indicators included fruits and vegetables, sweet/ savory snacks, high calorie beverages, and DASH score. Individual linear regression models were run where child BMI z-score and child diet quality indicators were dependent variables and HFE variables and child/

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parent characteristics were independent variables of interest. Fruit and vegetable consumption was associated with parental encouragement/modeling (β = 0.68, P<0.001) and unhealthful food availability (-0.27, P<0.05); DASH score with food availability (healthful: 1.3, P<0.01; unhealthful:-2.25, P<0.001), food rules (0.45, P<0.01) and permissive feeding style (-1.04, P<0.05); high calorie beverages with permissive feeding style (0.14, P<0.01) and unhealthful food availability (0.21, P<0.001); and sweet/savory snacks with healthful food availability (0.26, P<0.05; unexpectedly positive). Children's BMI z-score was positively associated with parent's use of food restriction (0.21, P<0.001), permissive feeding style (0.16, P<0.05), and concern for healthy food costs (0.10, P<0.01), but negatively with verbal encouragement / modeling (-0.17, P<0.05), and pressure to eat (-0.34, P<0.001). Various HFE factors associated with parenting around eating and food availability are related to child diet quality and weight status. These factors should be considered when designing interventions for improving child health.

Keywords

childhood obesity; home food availability; dietary quality; parenting; food rules

INTRODUCTION

Childhood overweight/obesity is a strong predictor of adult obesity[1] and risk factors for chronic diseases.[2, 3] A healthful diet during childhood is believed to reduce the risk of child overweight. However, in the US, unhealthful eating practices in youth, such as high intakes of high fat snacks and sugar sweetened beverages and low intakes of fruits and vegetables, are common.[4, 5] Although a multitude of factors play a role in child obesity and poor diet quality, current models for root causes point to the home food environment (HFE) as having a key influence.[6, 7]

Much of a child's eating behavior occurs in and around the home, so the potential impact of the HFE on a child's energy intake and overall diet quality is particularly relevant. Several models have been proposed to conceptualize the HFE as it pertains to child obesity.[7-9] Overlapping constructs within these models are the basis for our proposed model (Figure 1). These include the physical environment such as food and beverage availability and the sociocultural environment including parenting styles, practices and rules. A range of studies have examined aspects of these constructs providing insight into how the HFE is likely to shape children's food intake and weight. For example, the availability of unhealthy foods in the home has been associated with lower fruit and vegetable intake in children.[8,10] Parent's use of controlling child-feeding strategies has been positively related to BMI in girls,[11] and poor diet quality in boys and girls.[12,13] Family mealtime practices, including eating meals as a family and setting household food rules, have been associated with higher dietary quality in youth;[10,11] however, the relation of these practices to child BMI has been mixed.[14, 15]

Most previous studies of the HFE and children's eating behavior and weight status have been limited by small sample size and the small number of HFE factors and potential confounders examined. Although past studies examined aspects of the HFE in relation to diet quality or BMI in childhood, few have examined child HFE, diet and weight status

concurrently.[10, 11] To design effective intervention programs directed at chronic disease prevention in youth, it would be helpful to identify multiple aspects of the HFE that enhance a healthy weight while optimizing the overall nutrient intake of the child. The aim of the present study was to explore relationships between physical and sociocultural aspects of the HFE on diet quality and weight status in children. Proposed HFE predictors were considered simultaneously with relevant child/parent characteristics like gender, parent education and BMI.

EXPERIMENTAL METHODS

Study design, setting and subjects

Participants were part of the Neighborhood Impact on Kids (NIK) Study, an NIH funded longitudinal, observational cohort study of children aged 6 to 11 and their parents in Seattle/ King County, WA and San Diego County, CA. NIK was designed to evaluate the association of neighborhood and home environmental factors with children's and parent's weight status and weight-related behaviors.[16] Children who lived in neighborhoods that varied in their physical activity environment (PA) (e.g., walkability and availability of parks), and nutrition environment (NE) (e.g., availability of healthy food choices) were studied. Neighborhood PA and NE characteristics were assessed by observation, existing land use and other spatial data available in a Geographic Information System.[17] Block groups were assigned a low or high PA score and low or high NE score. Recruitment was guided by achieving about equal representation of participants from each of 4 neighborhood types: high PA /high NE, high PA/low NE, low PA/high NE, low PA/low NE. This study was approved by the Institutional Review Boards at Seattle Children's Hospital and San Diego State University. Parents provided written informed consent and children provided assent prior to study participation.

Participant recruitment occurred from September 2007 to January 2009. A total of 8616 households were contacted, 4975 were screened for interest/ eligibility, 944 agreed to participate, and 756 consented and had a measurement visit. Twenty-six families were later found to have inappropriate neighborhood type designation due to missing park and restaurant information and were excluded. Among the remaining 730 families, 699 child-parent pairs had available anthropometric and HFE data. These 699 pairs were the basis of this analysis. Only one child and parent were enrolled per household. Additional details regarding recruitment and inclusion/exclusion criteria have been published.[16]

Measures

All measures for these analyses were obtained during the initial measurement period. This included an assessment visit in the family's home or at Seattle Children's Hospital (determined by parental preference) to collect child and parent anthropometric data. A survey of demographic and HFE factors was completed by the participating parent over the next week and child diet recalls were completed within 3 weeks after the assessment visit. All data were collected by trained research personnel.

Survey—The survey was designed with detailed instructions for a parent to complete online or in writing. Copies of the NIK time 1 survey used in this investigation can be found at: http://www.seattlechildrens.org/research/child-health-behavior-and-development/saelens-lab/measures-and-protocols/. The survey included questions on demographics and the HFE. Demographics related to individual – level characteristics including child and parent age, gender, race, ethnicity and parent's work hours outside the home (<15, 15-35, >35 hours/ week). Household-level characteristics were also determined including highest level of adult education achieved in the household (categorized as ≤high school, some or completed college, and completed graduate degree) and household income (<50k, 50k-100k, and >100k). HFE measures were derived from published scales and related to parenting style/ feeding practices and home food availability. Specifically, an "Encouragement/Modeling" scale (7 items; Cronbach's α = 0.77) modified from the Pro Children Project[18] consisted of items about parent's use of modeling positive eating behaviors and encouragement to eat fruits and vegetables. A "Pressure to Eat" scale (4 items; Cronbach's α = 0.76) and a "Restrictive Food Practices" scale (2 items; Cronbach's α = 0.78) from the Child Feeding Questionnaire developed by Birch et al.[19] included items about feeding strategies to get a child to eat and use of food restriction to control a child's food intake. A "Permissive Food Practices" scale (3 items; Cronbach's α = 0.55) from the Family Eating and Activity Habits Questionnaire[20] included items about eating without limits and a "Household Food Rules" scale (12 items; Cronbach's α = 0.60) from the Active Where Parent-Child Survey (available at: http://sallis.ucsd.edu) included items about rules enforced in the home related to child eating. Two additional scales from the Active Where Parent-Child Survey assessed home food availability related to high calorie /nutrient poor foods (8 items including chocolate candy, other candy, cakes/brownies/muffins/cookies, regular chips/crackers, sweetened breakfast cereals, juice drinks, regular sodas and sports drinks; Cronbach's α = 0.76) and lower calorie/more nutrient dense foods (4 items including raw fruits, baked chips/ low fat crackers/pretzels, raw vegetables, and unsweetened cereals; Cronbach's α = 0.52). A "Frequency of Dinners Out" item from the Youth and Adolescent Food Frequency Questionnaire[21] assessed how often the child ate dinner away from home. A scale on food costs (2 items; Cronbach's α = 0.64) asked parents about their perception of costs of fruits and vegetables in neighborhood stores.[22] All items except food rules were scored using a five point Likert scale ranging from 1 (low) to 5 (high). Items within a scale were summed and averaged. The average was then used as the scale score. Food rules were scored as 1 (yes) and 0 (no) response and the "Household Food Rules" score was a sum of these responses. All HFE scales had been previously tested for internal consistency and test-retest reliability. Cronbach's α for the scales within this sample were consistent with published values. HFE scales within this sample also had good individual predictive ability as demonstrated by significant independent associations with fruit and vegetable intake and/or child BMI z-score (Online Supplemental Table A).

Dietary Intake—Participants were called on up to 3 random days (98% had 3 recall days; 68% had 1 weekend day and 2 weekends; others had 3 weekdays) and asked to recall their food intake in the previous 24 hours using the multiple-pass method.[23] Prior to the recalls during measurement visits, children and their parents were trained in the use of a 2-dimensional food models to assist with estimation of portion sizes of foods eaten (Nutrition

Consulting Enterprises; Framingham, MA). Telephone interviews were conducted using the consensus recall approach (where parents and their child reported as a group) for children younger than 8 years of age.[24] Children at or over the age of 8 years were interviewed for dietary recall information with parental assistance.[25-27]

Food recalls were averaged over the 3 days and analyzed for calorie intake, nutrient content and number of servings from food groups using the Minnesota Nutrient Data Systems for Research (NDSR) software, version 2.92 (2010). Given the association between energy density and nutrient quality, [28] two additional food groupings were created that reflected foods of high energy density: high calorie, non-dairy beverages excluding 100% juice and sweet and savory snacks. A third additional food grouping was created of low energy dense foods including all forms of fruits and vegetables except savory snacks and fried types. Definitions of food groups, serving sizes and representative foods within groups are shown in Table 1.

A DASH score was calculated according to Guenther et al. [29] from mean daily food group servings of 8 food groups - grains, vegetables, fruits, dairy, meat/poultry/fish/eggs, nuts/seeds/legumes, fats/oils, and sweets. Goals of intake for each food group were based on recommendations specified by the Dietary Guidelines for Americans,[30] the DASH Collaborative Research Group,[31] and on calorie levels specific for age, gender, and sedentary activity level.[32] A maximum score of 10 was achieved within each food group when a child's intake met the food group recommendation, whereas lower intakes were scored proportionately. If lower intakes were favored by the dietary recommendation, reverse scoring was applied. An overall DASH score was calculated, which ranged between 0 and 80, with a higher score indicating a higher diet quality.

Anthropometrics—Parent/child weight and height were measured 3 or more times until 3 of 4 consecutive readings were within 0.1 kg for weight and 0.5 cm for height. Readings were averaged. Weights were obtained with a digital scale (Detecto DR400C) and heights with a stadiometer (SECA 214). BMI was calculated as weight/height^2 (kg/m^2), with BMI percentiles, BMI z-scores and weight status cut-points defined as per the Centers for Disease Control and Prevention (CDC) criteria.[33]

Statistical Analyses

Data were analyzed using Stata version 12.1 (StataCorp. 2011. Stata Statistical Software: Release 12. College Station, TX: StataCorp LP.) Bivariate associations among HFE scales were assessed using Pearson correlations. Five individual linear regression models were run where child BMI z-score, fruit and vegetable intake, DASH score, sweet and savory snack servings and high calorie beverage servings were dependent variables and social cultural variables (parenting style/feeding practices, food rules, frequency of eating out, and parent's perception of food costs), physical environment (healthful and unhealthful home food availability) and child/parent characteristics (child age, gender, race, ethnicity, parent's BMI, highest household education level and child BMI z-score in models for diet quality indicators only) were independent variables of interest. A multiple logistic regression model was conducted similarly for odds of child overweight (BMI ≥85th percentile for age and

gender) as the dependent variable. Neighborhood type was included in all models to account for the study recruitment/sampling design. Notably, as a measure of socioeconomic status, highest household education was included in models rather than income to avoid collinearity (these variables were highly correlated). P values <0.05 were considered significant.

RESULTS AND DISCUSSION

Participant characteristics

Children and parents were predominantly non-Hispanic white; the prevalence of overweight/obesity was 26.6% in children and 41.9 % in parents (Table 2). On average, children consumed considerably less than the 6-9 servings of fruits and vegetables recommended for their age group; mean energy intake fell within age-appropriate ranges.[31] The average DASH score for children was 58% of the maximum achievable score of 80.[30] Annual household income was >$50K for 85% of the sample. Parent participants were predominately female (86%), had a minimum of some college education (93%), and 47.5% worked less than 15 hours per week outside the home.

Mean HFE scores (Table 3) showed a high use of encouragement/modeling and restrictive feeding practices in this sample and a high availability of low calorie/nutrient dense foods in the home. Other parenting and food availability measures were near the middle of the possible score range. On average, families reportedly ate dinners out 1-2 times per week (this based on a Likert scale score where a mean of 2 = 1-2 per week). Most HFE scales were only modestly inter-correlated ($r \leq 0.3$). Exceptions included the scale for family food rules, which was moderately correlated with encouragement/modeling (r=0.45) and permissive practices related to child eating (r=-0.39). Also, the unhealthy food availability scale was moderately correlated with permissive practices related to child eating (r=0.36).

Associations between HFE scales, child diet quality and weight status

In multivariate models (Table 4) child diet quality indicators tended to be more consistently associated with home food availability scales than parenting around eating. As evidence, home availability of unhealthful foods was positively associated with high calorie beverage intake and inversely with fruits and vegetable intake and DASH score. Availability of healthful foods was positively associated with DASH score and unexpectedly with sweet and savory snacking. Parenting practices that were favorably associated with high diet quality indicators included encouragement / modeling of healthy eating and family rules around child eating. Permissive parenting style was inversely related to DASH score. Several child/parent characteristics were associated with child diet quality. DASH score was inversely associated with parent BMI and parent education (college compared to high school). Sweet and savory snacking was positively associated with child race (white compared to non-white) and parent education (college or more compared to high school) and negatively with child ethnicity (Hispanic compared to non-Hispanic). Also, high calorie beverage intake was positively associated with child age and negatively with child gender (female compared to male). Multivariate models predicting child energy intake were also run and showed no significant associations with HFE scales or child/parent characteristics (data not shown).

Child weight status was associated with several aspects of parenting around child eating. Child BMI z-score was negatively associated with parent's use of encouragement/modeling and parental pressure to eat and positively associated with parent's use of food restriction, permissive feeding practices, and parent's concern over healthy food costs. Similarly, odds of a child being overweight were lower with increased parental pressure to eat and higher with parental use of permissive feeding practices and use of food restriction. Child-parent characteristics associated with child weight status included child gender and parent BMI. Specifically, child BMI z-score was negatively associated with child gender (female compared to male) and positively associated parent BMI; Odds of a child being overweight were lower with being female compared to male and higher with greater parent BMI.

Interpretation

A major finding from the present analyses was that the combination of sociocultural and physical HFE variables assessed explained 28% of the variance in child BMI and 9% to 21% of the variance in various measures of child dietary quality. These are substantial associations and suggest that changing the HFE has the potential to be a strong intervention approach. Another finding was that sociocultural characteristics of the home environment that included parenting around child eating and permissive parenting style were more consistently related to child weight than physical resources including the healthfulness of available food in the home; results suggest potentially effective and ineffective parenting practices. Conversely, the healthfulness of home food availability was more consistently related to child diet quality than parenting was related to child eating; this suggests that a healthy HFE is an important means of optimizing the overall nutritional quality of children's diets.

The present study has several strengths including the consideration of multiple aspects of the HFE simultaneously on both child weight and diet quality. Also, ~ 700 children and their caregivers from two metropolitan areas were studied allowing for important differences in associations between the HFE and child diet intake and weight to be identified. To our knowledge this is the first study to show a favorable association between parental encouragement/modeling and child weight status and fruit and vegetable intake after accounting for other parenting practices around child eating, home food availability, and important child/parent characteristics such as parent BMI. While several cross-sectional studies have shown positive associations between parental modeling and children's fruit and vegetable consumption, [34-36] our results suggest this practice may have benefits regarding children's weight. Permissive versus authoritarian parenting around eating was found to be problematic for both child weight and diet quality as reflected by associations with lower DASH score and higher caloric beverage consumption. These findings are consistent with cross-sectional data showing that indulgent parents had children with higher BMI z-scores [37, 38] and lower dairy and vegetable intakes.[39] Findings from this study also showed that parental enforcement of "allow/limit" rules on snacking type, place, and size were associated with higher DASH score, consistent with the findings of others.[40] Perceived use of restrictive parenting practices around child eating was associated with higher child BMI z-score but not diet quality indicators, consistent with some research[41-43] but not others.[44-46] Although parental pressure directed at child eating has been reported to be a

counterproductive feeding approach, [34, 47, 48] our data suggest otherwise. It is possible that parents apply pressure during feeding because the child is underweight, eating too slowly, or displaying eating behaviors that are perceived as problematic.[49] Longitudinal data support this interpretation. [35, 50, 51]

Not surprisingly, a greater availability of healthful foods in the home was associated with a higher child DASH score. Several studies have related home availability of healthful foods to consumption in children, and the present findings were in line with existing research.[8, 49] The inverse association observed between high fruit and vegetable intake and DASH score and availability of unhealthful foods suggest that limiting these foods may be advantageous toward improving children's diet quality. An unexpected finding was the positive association between the availability of low calorie/nutrient dense foods in the home and the child's intake of sweet and savory snacks. This finding may be related in part to how sweet and savory snacks were categorized in this study or reflect the state of some HFE, i.e., some homes may be healthful in some ways but not others.

Limitations of the present study include the cross-sectional nature of the design, which can identify associations, but cannot determine the direction of the association. Bi-directionality in parent-child interactions is likely as parenting influences child eating and weight, but child eating and weight also influence parenting. Only longitudinal and experimental studies can provide evidence of the temporal nature of these associations. Although it is likely that aspects of the HFE exert influence on a child's weight via their dietary intake, these relationships were not directly examined in the present study. All survey and dietary data for children younger than 8 years of age were collected from the parent's self-report, which may have introduced self-report bias.[52] Also, the parents surveyed in this study were highly educated (most with some college or were college graduates), which limits the generalizability of these findings.

CONCLUSIONS

The HFE plays an important role in shaping dietary intake and weight status in children. In particular, the parenting practices of encouragement/modeling of healthy eating, setting "allow/limit" home food rules, and having healthful foods available in the home were favorably associated with child dietary quality and/or weight status. In contrast, permissive parenting practices around child eating and restrictive feeding practices were adversely related to child dietary intake and/or weight status. These findings suggest that parental encouragement and modeling of healthy eating, that is not overly restrictive, but in the context of a healthy home food environment is important in order to maximize the likelihood of healthy child weight status and eating. More longitudinal and experimental research is needed to clarify the precise role of the HFE in children's intake and weight trajectories.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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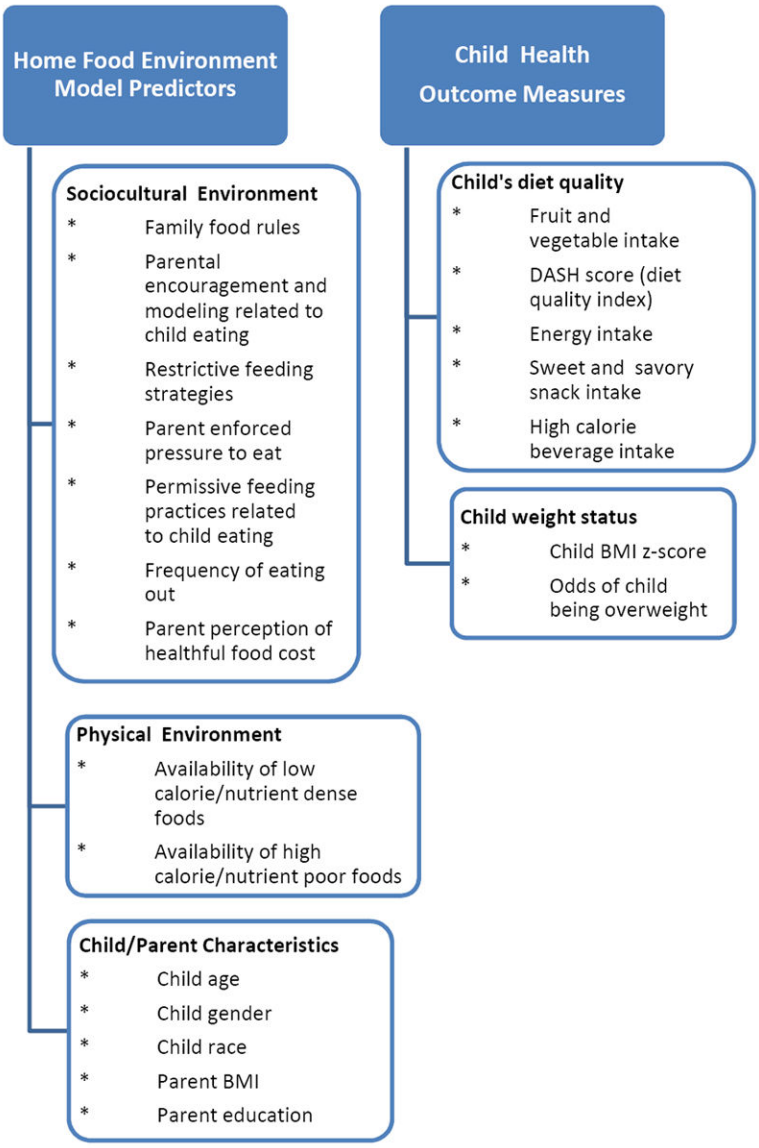

Figure 1.

Model of the home food environment predictors of child diet quality and weight status. Neighborhood type was also included in models to account for participant recruitment strategy.

Table 1

Description of food groups used as dependent variables in regression models to assess the relationship between the home food environment, diet quality and weight status of children 6 to 11 years of age [a]

Food Group	Definitions	Representative Food Types
Fruits and vegetables [b]	Whole fruit and 100% fruit juice, whole vegetables and 100% vegetable juice; fruits and vegetables in salads, soups, stews, stir-fry and similar mixed dishes; excludes fried fruits and vegetables	Citrus or other fruit juice, vegetable juice, apples, oranges, bananas, berries, avocado, broccoli, collards, romaine, carrots, winter squash, sweet potatoes, salsa, tomato sauce, tomato puree and paste, white potatoes, corn, lima beans, peas, beans, lentils, beets, cabbage summer squash
Sweets and savory snacks [c]	High energy, low nutrient dense solid snack-type foods	Apple and banana chips, potato/corn/rice chips, crackers, cheese puffs, cakes, cookies, pies, pastries, doughnuts, snack bars, popcorn, fried pork rinds, candy, frosting, fudge, caramel, honey, jam, sugar, energy bars, granola bars
High calorie beverages (non-dairy excluding 100 % fruit juice) [c]	High energy drinks were those that contained caloric sweeteners. High calorie beverage inclusion criteria was based on the CDC definition[54] except sweetened milks or milk alternatives were not included because of presence of protein and other nutrients	Flavored carbonated or non-carbonated soft drinks (soda), fruit drinks, punches or ades, sports drinks, tea and coffee drinks (caloric sweeteners are added), and energy drinks.

[a] Data are from the Neighborhood Impact on Kids (NIK) study, an NIH longitudinal observational cohort study of children and their parents in Seattle/King County, WA and San Diego, CA.[16]

[b] Serving sizes were calculated based on those recommended in the Dietary Approaches to Stop Hypertension (DASH) dietary pattern.[31]

[c] Serving sizes were calculated based on USDA standards. [53]

Table 2

Characteristics of children [a, b] and their parents [a, c] used in regression models to assess the relationship between the home food environment, diet quality and weight status of children 6 to 11 years of age

Characteristic	Definition	n	%	Mean (SD)
Children (n=699)				
Age (years)				9.1 (1.5)
	6-8	349	49.9	
	9-11	350	50.1	
Gender	Male	351	50.2	
	Female	348	49.8	
Race	White	568	81.2	
	Non-White	131	18.7	
Ethnicity	Hispanic	119	17.1	
	Non-Hispanic	577	82.9	
BMI z-score				0.43 (0.98)
	<85th percentile	513	73.4	
	85th to <95th percentile	106	15.2	
	≥95th percentile	80	11.4	
Dietary intake	Energy, kcal/day			1752 (414)
	Fruit and vegetables, servings/day [d]			3.4 (2.0)
	Sweet and savory snacks, servings/day [e]			2.3 (1.5)
	High calorie beverages, servings/day [f]			0.6 (0.7)
	DASH score [g]			41.5 (7.1)
Parents (n=699)				
Age, years				41.4 (5.9)
Gender	Male	96	13.9	
	Female	596	86.1	
Race	White	605	88.9	
	Non-White	76	11.1	
Ethnicity	Hispanic	95	13.8	
	Non-Hispanic	595	86.2	
Parent work hours outside the home/week	<15 hours	329	47.5	
	15-35	155	22.4	
	>35	208	30.1	

Characteristic	Definition	n	%	Mean (SD)
Highest level of adult education in the household	No college	46	6.7	
	Some or College graduate	392	56.9	
	Graduate school	251	36.4	
Household Income [h]	<50k	97	14.2	
	50k-100k	252	37.0	
	>100k	332	48.8	
BMI, kg/m^2				27.0 (5.8)
	Normal (BMI < 25)	404	58.1	
	Overweight (≥25 BMI < 30)	120	17.2	
	Obese ≥ 30	172	24.7	

[a] Data are from the Neighborhood Impact on Kids (NIK) study, an NIH longitudinal observational cohort study of children and their parents in Seattle/King County, WA and San Diego, CA.[16]

[b] Child demographics were collected by study staff at the study assessment visit.

[c] Parent demographics were collected by survey; parent and child weight and height were measured at the study assessment visit (at family's home or in the hospital depending on parent preference).

[d] Fruit and vegetables included whole and 100% juice in salads, soups, stews, stir-fry and similar mixed dishes and excluded fried fruits and vegetables; serving sizes were calculated according to the DASH [31] dietary pattern.

[e] Sweet and savory snacks included high energy, low nutrient dense solid snack-type foods. USDA [53] serving sizes were used to assess portion sizes consumed.

[f] High calorie beverages were those that contained caloric sweeteners. High calorie beverage inclusion criteria were based on the CDC definition[54] except sweetened milks or milk alternatives were not included because of presence of protein and other nutrients. USDA [53] serving sizes were used to assess portion sizes consumed.

[g] DASH score was calculated according to Guenther et al.; [29] possible score ranged from 0 to 80 with higher score = higher diet quality.

[h] As a measure of socioeconomic status, highest household education was included in regression models rather than household income to avoid collinearity (these variables were highly correlated).

Table 3

Means (SD), range and Pearson correlation between home food environment scales used as independent variables in regression models to assess the relationship between the home food environment, diet quality and weight status of children 6 to 11 years of age [a]

Home Food Environment Scales	Factor Mean (SD)	Factor Range [b]	1	2	3	4	5	6	7	8
Sociocultural Environment										
1. Encouragement and modeling related to child eating [c]	4.2 (0.5)	1 to 5								
2. Restrictive food practices [d]	3.7 (1.1)	1 to 5	0.10							
3. Pressure to eat [e]	2.2 (0.9)	1 to 5	-0.02	0.09						
4. Permissive practices related to child eating [f]	2.1 (0.6)	1 to 5	-0.21 ****	0.02	0.14 **					
5. Family rules related to child eating [g]	5.4 (2.0)	0 to 12	0.45 ****	0.23 ****	0.12	-0.39 ****				
6. Frequency of dinners out per week [h]	2.2 (0.9)	1 to 5	-0.10	-0.05	-0.01	0.12	-0.09			
7. Parent concern of healthy food costs [i]	2.6 (1.1)	1 to 5	-0.09	-0.01	0.12	0.12	-0.01	-0.09		
Physical Environment										
8. Availability of low calorie/ nutrient dense foods [j]	4.2 (0.5)	1 to 5	0.29 ****	0.02	-0.14 *	-0.18 ****	0.15 **	-0.08	-0.19 **	
9. Availability of high calorie/ nutrient poor foods [k]	2.7 (0.7)	1 to 5	-0.27 ****	-0.12	0.14 **	0.36 ****	-0.35 ****	0.17 ***	0.10	-0.01

[a] Data are from the Neighborhood Impact on Kids (NIK) study, an NIH longitudinal observational cohort study of children and their parents in Seattle/King County, WA and San Diego, CA.[16]

[b] All items except food rules were scored using a Likert scale ranging from 1 (low/disagree/never) to 5 (high/agree/always); Food rules were scored as 1 (yes) and 0 (no) response; Items within a scale were summed and averaged. The average was then used as the scale score. Frequency of dinners out per week were scored as 1= never; 2= 1-2 times per week, 3 = 2-3 times per week, 4 = 4-5 times per week; 5 = >5 times per week; Bonferroni adjusted significance levels are reported.

[c] includes 7 items modified from the Pro Children Project[18] that relate to parent's use of modeling positive eating behaviors and encouragement to eat fruits and vegetables.

[d] includes 2 items from the Child Feeding Questionnaire [19] about parent's use of food restriction to control a child's food intake.

[e] includes 4 items from the Child Feeding Questionnaire [19] about feeding strategies to get a child to eat more.

[f] includes 3 items from the Family Eating and Activity Habits Questionnaire [20] about eating without limits.

[g] includes 12 items from the Active Where Parent-Child Survey (available at: http://sallis.ucsd.edu) about rules enforced in the home related to child eating.

[h] includes 1 item from the Youth and Adolescent Food Frequency Questionnaire[21] to assessed how often the child ate dinner away from home.

[i] includes 2 items to assess parent's perception of costs of fruits and vegetables in neighborhood stores.[22]

[j] includes 4 items to assess home availability of low calorie/ nutrient dense foods (includes raw fruits, baked chips/ low fat crackers/pretzels, raw vegetables, and unsweetened cereals).

[k] includes 8 items to assess home availability of high calorie /nutrient poor foods (includes chocolate candy, other candy, cakes/brownies/muffins/cookies, regular chips/crackers, sweetened breakfast cereals, juice drinks, regular sodas and sports drinks).

* P<0.05.

** P<0.01.

*** P<0.001.

**** P<0.0001.

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Table 4

Estimated associations between home food environment, child/parent characteristics, dietary quality and weight status of children 6 to 11 years of age [a, b]

	Child Diet Quality Indices				Child Weight Status Indices	
Home Food Environment Scales	**Fruit and vegetable intake [c]**	**DASH score [d]**	**Sweet and Savory Snacks [e]**	**High Calorie Beverages [f]**	**Child BMI z-score [g]**	**Child Overweight [g]**
	Estimate (95% CI) [h]	**Estimate (95% CI) [h]**	**Estimate (95% CI) [h]**	**Estimate (95% CI) [h]**	**Estimate (95% CI) [h]**	**Odds Ratio (95% CI) [h]**
Sociocultural Environment Scales						
Encouragement and modeling related to child eating	0.68 (0.34, 1.02) ***	1.13 (-0.03, 2.30)	-0.11 (-0.38, 0.17)	-0.01 -0.12, 0.11)	-0.17 (-0.32, 0.02) *	0.65 (0.42, 1.03)
Restrictive food practices	-0.04 (-0.19, 0.11)	-0.17 (-0.67, 0.33)	-0.04 (-0.15, 0.08)	0.04 (-0.01, 0.09)	0.21 (0.14, 0.27) ***	1.83 (1.47, 2.28) ***
Pressure to eat more	-0.16 (-0.33, 0.02)	-0.19 (-0.79, 0.41)	-0.13 (-0.27, 0.01)	0.02 (-0.04, 0.08)	-0.34 (-0.42, -0.27) ***	0.46 (0.36, 0.60) ***
Permissive practices related to child eating	0.05 (-0.23, 0.33)	-1.04 (-2.00, -0.08) *	0.20 (-0.02, 0.42)	0.14 (0.05, 0.24) **	0.16 (0.04, 0.29) *	1.68 (1.16, 2.42) **
Family rules related to child's eating	0.05 (-0.04, 0.14)	0.45 (0.14, 0.77) **	-0.03 (-0.10, 0.04)	-0.03 (-0.06, 0.003)	0.04 (-0.002, 0.08)	1.06 (0.94, 1.19)
Frequency of dinners out /week	-0.08 (-0.24, 0.08)	-0.03 (-0.57, 0.51)	0.02 (-0.11, 0.15)	0.02 (-0.03, 0.08)	0.07 (-0.003, 0.14)	1.20 (0.98, 1.48)
Parent concern of healthy food costs	-0.02 (-0.17, 0.13)	-0.19 (-0.68, 0.31)	0.001 (-0.11, 0.12)	-0.02 (-0.07, 0.03)	0.10 (0.03, 0.16) **	1.18 (0.97, 1.43)
Physical Environment Scales						
Availability of low calorie/ nutrient dense foods	0.13 (-0.16, 0.42)	1.30 (0.31, 2.28) **	0.26 (0.03, 0.49) *	-0.02 (-0.12, 0.07)	-0.02 (-0.05, 0.11)	0.98 (0.66, 1.46)
Availability of high calorie/ nutrient poor foods	-0.27 (-0.52, -0.03) *	-2.25 (-3.08, -1.41) ***	-0.002 (-0.20, 0.19)	0.21 (0.13, 0.29) ***	-0.01 (-0.12, 0.10)	0.81 (0.58, 1.13)
Child/Parent Characteristics [i, j]						
Child age	0.09 (-0.01, 0.18)	-0.12 -0.44, 0.21)	-0.02 (-0.10, 0.06)	0.03 (0.0005, 0.06) *	0.04 (-0.08, 0.005)	1.06 (0.93, 1.20)
Child race						
Non-white (reference)						

Home Food Environment Scales	Child Diet Quality Indices				Child Weight Status Indices	
	Fruit and vegetable intake [c]	DASH score [d]	Sweet and Savory Snacks [e]	High Calorie Beverages [f]	Child BMI z-score [g]	Child Overweight [g]
	Estimate (95% CI) [h]	Estimate (95% CI) [h]	Estimate (95% CI) [h]	Estimate (95% CI) [h]	Estimate (95% CI) [h]	Odds Ratio (95% CI) [h]
White	0.14 (-0.23, 0.51)	0.87 (-0.38, 2.13)	0.44 (0.15, 0.73) **	0.01 (-0.11, 0.14)	0.03 (-0.14, 0.19)	0.96 (0.59, 1.58)
Child ethnicity						
Non-Hispanic (reference)						
Hispanic	0.13 (-0.28, 0.54)	0.37 (-1.04, 1.78)	-0.40 (-0.73, -0.08) *	0.10 (-0.04, 0.24)	.06 (-0.13, 0.24)	1.22 (0.71, 2.08)
Child gender						
Male (reference)						
Female	-0.16 (-0.46, 0.13)	-0.79 (-0.21, 1.80)	22 (-0.45, 0.02)	-0.20 (-0.30, -0.10) ***	-0.20 (-0.33, -0.07) **	0.61 (0.41, 0.91) *
Child Weight status						
Normal weight (reference)						
Overweight	0.10 (-0.32, 0.52)	0.69 (-0.74, 2.12)	-0.10 (-0.43, 0.23)	-0.05 (-0.19, 0.09)		
Obese	0.26 (-0.25, 0.76)	0.40 (-1.32, 2.12)	-0.07 (-0.47, 0.33)	-0.07 (-0.24, 0.10)		
Parent BMI	-0.02 (-0.04, 0.009)	-0.11 (-0.20, -0.02) *	-0.006 (-0.03, 0.02)	0.01 (-0.001, 0.02)	0.05 (0.04, 0.06) ***	1.10 (1.07, 1.14) ***
Parent education						
≤High School (reference)						
College	-0.26 (-0.89, 0.37)	-2.19 (-4.34, -0.04) *	0.56 (0.08, 1.08) *	0.08 (-0.13, 0.29)	-0.12 (-0.40, 0.16)	0.73 (0.32, 1.65)
Graduate School	0.04 (-0.63, 0.71)	-1.20 (-3.48, 1.09)	0.83 (0.30, 1.36) **	0.04 (-0.19, 0.26)	-0.14 (-0.43, 0.16)	0.82 (0.35, 1.96)
Model R^2	.10	.21	.09	.16	.28	

[a] Data are from the Neighborhood Impact on Kids (NIK) study, an NIH longitudinal observational cohort study of children and their parents in Seattle/King County, WA and San Diego, CA.[16]

[b] N=699 child-parent pairs: participating parent was asked to report on home food environment scales for child in the study.

[c] Fruit and vegetables included whole and 100% fruit juice, in salads, soups, stews, stir-fry and similar mixed dishes and excluded fried fruits and vegetables; serving sizes were calculated according to the DASH [31] dietary pattern.

[d] DASH score was calculated according to Guenther et al.; [29] possible score ranged from 0 to 80 with higher score = higher diet quality.

[e] Sweet and savory snacks included high energy, low nutrient dense solid snack-type foods. USDA [53] serving sizes were used to assess portion sizes consumed.

[f] High calorie beverages were those that contained caloric sweeteners. High calorie beverage inclusion criteria were based on the CDC definition[54] except sweetened milks or milk alternatives were not included because of presence of protein and other nutrients. USDA [53] serving sizes were used to assess portion sizes consumed.

[g] BMI was calculated as weight/height^2 (kg/m^2), with BMI z-scores and weight status cut-points defined as per the Centers for Disease Control and Prevention (CDC) criteria.[33]

[h] All models were adjusted for neighborhood type to account for study participant recruitment strategy. Neighborhood type was based on physical activity (PA) environment and nutrition environment (NE) as assessed by observation and existing land use and other spatial data. Neighborhoods were assigned a low or high PA environment score based on walk index and park proximity and low or high NE score based on supermarket and fast food access. Four neighborhood types were possible = high PA /high NE, high PA/low NE, low PA/high NE or low PA/low NE. There was no significant association between neighborhood type and child health outcome (diet quality indicators, weight status indicators).

[i] Child demographics were collected by study staff at the assessment visit.

[j] Parent demographics were collected by survey; parent and child weight and height were measured at the assessment visit (at family's home or in the hospital depending on parent preference).

* P<0.05.

** P<0.01.

*** P<0.001.