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J Acad Nutr Diet. Author manuscript; available in PMC 2017 June 01.

Published in final edited form as:
J Acad Nutr Diet. 2016 June ; 116(6): 984–990. doi:10.1016/j.jand.2016.02.011.

Parent Diet Quality and Energy Intake Are Related to Child Diet Quality and Energy Intake

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Abstract

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Conflict of Interest Disclosures: Authors do not have any conflict of interests to disclose.

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Background—Parents' diets are believed to influence their children's diets. Previous studies have not adequately and simultaneously assessed the relation of parent and child total diet quality and energy intake.

Objective—To investigate if parent and child diet quality and energy intakes are related.

Design—A cross-sectional analysis using baseline dietary intake data from the Neighborhood Impact on Kids (NIK) study collected in 2007-2009.

Participants/setting—Parents and 6-12 year old children from households in King County (Seattle area), WA and San Diego County, CA, targeted by NIK were recruited. Eligible parent-child dyads (n=698) with two or three 24-hour dietary recalls were included in this secondary analysis.

Main Outcome Measures—Child diet quality (Healthy Eating Index-2010 [HEI-2010], Dietary Approaches to Stop Hypertension [DASH] score, and energy density (for food-only) and energy intake were derived from the dietary recalls using Nutrition Data Systems for Research.

Statistical Analyses Performed—Multiple linear regression models examined the relationship between parent diet quality and child diet quality, and the relationship between parent energy intake and child energy intake. In both analyses, we controlled for parent characteristics, child characteristics, household education and neighborhood type.

Results—Parent diet quality measures were significantly related to corresponding child diet quality measures: HEI-2010 (standardized beta [β] = 0.39, $p<0.001$); DASH score (β = 0.33, $p<0.001$); energy density (β = 0.32, $p<0.001$). Parent daily average energy intake (1763 ± 524 kilocalories) also was significantly related (β = 0.30, $p<0.001$) to child daily average energy intake (1751 ± 431 kilocalories).

Conclusion—Parent and child intakes were closely related across various metrics of diet quality and for energy intake. Mechanisms of influence are likely to be shared food environments, shared meals, and parent modeling.

Keywords

nutrition; family influence; 24-hour recall; healthy eating index; DASH score

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The Dietary Guidelines for Americans recommend that individuals two years of age or older consume nutrient-dense foods (e.g., fruits, vegetables, whole grains, low-fat dairy products, lean meats) to promote health and reduce chronic disease risk.[1] Despite these recommendations, usual intakes from 2007-2010 demonstrated that the majority of children were not meeting recommendations for fruits, vegetables, whole grains, and dairy.[2] In fact, children were consuming large quantities of energy from dietary components targeted for reduction, such as added sugars and solid fats.[3] Consumption of larger portions[4] and nutrient-poor, energy dense foods[5] have been associated with higher weight and obesity in children.

Eating behaviors adopted during childhood have been found to track into adulthood.[6] In childhood, eating behaviors are commonly acquired through observational learning[7] influenced by the home food environment, which include parent directed child feeding

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strategies.[8,9] Parents are considered to be the gatekeepers of food, particularly for young children[9,10] and have the primary responsibility for feeding their children.[11] Thus, a parent's diet can be expected to have a substantial impact on a child's diet.[12] However, results are mixed regarding the common perception that parent and child intakes are similar, and very few studies have examined the resemblance between children and their parents' in overall dietary quality and energy intake.[13] A meta-analysis by Wang and colleagues[13] examined parent-child dyad studies focused only on total energy and dietary fat and found weak associations between parent and child percent energy from fat (r = 0.20, 95% CI 0.13-0.28) and energy intake (r = 0.21, 95% CI 0.18-0.24).

Previous findings need to be interpreted with caution due to variability in dietary assessment methods and focus on selected components of the diet (e.g., energy, fat) instead of broader dietary patterns that may be more strongly related to health outcomes. Diet quality indices provide a better representation of overall dietary patterns.[14] Dietary intake as measured by multiple 24-hour recalls,[15] or records have have demonstrated stronger correlations between parent and child intake than when using food frequency questionnaires.[13]

More accurate diet quality data on parent and child were analyzed in the current study using: Healthy Eating Index (HEI-2010),[16,17] Dietary Approaches to Stop Hypertension (DASH) score,[18] and energy density (ED)[19]. The present study builds upon previous findings and uses data collected from a large sample of parent-child dyads to estimate the association of parent diet quality and energy intake on child diet quality and energy intake. In particular, confounding variables from both the parent and child were controlled for within the analysis to allow for a more precise estimation of the relationship between parent and child diet quality and energy intake.

Methods

Study Population

Parent-child dyads were part of the Neighborhood Impact on Kids (NIK) study, a longitudinal cohort study that examined differences in neighborhood environments in relation to obesity and related behaviors among children (6-12 years old) and parents living in King County (Seattle area) WA and San Diego County CA.[20] Neighborhood physical activity environments (PA) and nutrition environments (NE) were assessed using existing land use and street network data (e.g residential or commercial uses), food establishment data (e.g. availability of restaurants), park observations (e.g. park availability and quality), and other spatial data (e.g. residential density) in a Geographic Information System to assign neighborhoods to low or high PA scores and low or high NE scores.[21] High PA and NE neighborhoods indicated a more favorable neighborhood environment for these factors.

From September 2007 to January 2009 parents and children were recruited based on neighborhood type (high PA/high NE; high PA/low NE; low PA/high NE; low PA/low NE). Eligible parent-child dyads had to: 1) live ≥5 days per week in one of the identified neighborhoods; 2) be able to engage in at least moderate-intensity physical activity; 3) not have a medical condition associated with obesity (e.g., Cushing's syndrome); and 4) not be participating in a medical treatment known to impact growth. Parent-child dyads were

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excluded if the child had a chronic illness known to affect growth; ≤10th percentile BMI for age and sex based on parent report; had eating disorder pathology; on medically prescribed dietary regimen; or had psychiatric problems that would interfere with participation. Only one child per household was eligible to participate and the parent had to be the legal guardian.

A total of 8,616 households were contacted, 4,975 were screened for interest and eligibility. Of the 944 who agreed to participate, 730 families attended an anthropometric measurement visit and provided consent/assent. At the beginning of the anthropometric measurement visit the study procedures were described in detail with each parent and child. After addressing any questions, written consent was obtained from the parent and assent was obtained from the child. Among these dyads, 698 families had both the parent and child having two or three days of dietary recalls (on the same days) and were included in this secondary analysis. Demographic and anthropometric characteristics of parents and children included (n=698) did not significantly differ from parents and children excluded (n=32) from this analysis (not shown). The study protocol was approved by the Institutional Review Boards at Seattle Children's Hospital and San Diego State University.

Measures

Demographics—Individual (e.g., child and parent age, race, sex, etc.) and household-level demographic (e.g., highest level of education for the adult) information was collected by parent completion of a questionnaire (available at: http://www.seattlechildrens.org/research/child-health-behavior-and-development/saelens-lab/measures-and-protocols/).

Anthropometrics—Parent and child height and weight were collected by a trained research assistant at the clinic or the family's home (based on parent location preference). Weight and height were measured in at least triplicate to the nearest 0.1kg and 0.1cm, respectively, using a digital scale (Detecto 750; Detecto DR400C) and stadiometer (235 Heightronic digital stadiometer, portable SECA 214). Further measurements were taken until 3 of 4 consecutive measures were within 0.1cm and 0.1kg respectively. The child's BMI was calculated and the value was standardized relative to the CDC 2000 norms to determine standardized BMI (z-BMI).[22] BMI (kg/m^2) was also calculated for parents defining overweight as BMI ≥ 25 kg/m^2 and obesity as BMI ≥ 30 kg/m^2.[23]

Dietary Intake—Dietary intake of each parent and child was assessed by up to three random, 24-hour dietary recalls representative of both week day and weekend days conducted by trained staff over the phone using a standard multiple-pass approach. Recalls were planned to occur within three weeks of the anthropometric measurement visit, but the timeframe was extended when necessary to obtain up to 3 recalled days. Staff used a self-/parent-report approach thus, additional resources (e.g. schools) were not consulted. For children younger than eight years-old, a consensus recall approach was used with parents and children reporting together; children eight years-old or older reported individually with parent assistance. At the anthropometric measurement visit, parent-child dyads were given two-dimensional food models to assist with portion estimation during the phone recalls. Recall data were analyzed using Nutrition Data System for Research (NDS-R) (version 2.92,

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2010, Nutrition Coordinating Center, University of Minnesota) software. NDS-R is based on the United States Department of Agriculture Nutrient Data Laboratory as the primary source of nutrient values and composition with supplementation of food manufacturers' information and data available in the scientific literature.[24] NDS-R uses standardized published imputation procedures to minimize missing values.[25] Child and parent diet quality and energy intake estimates were based on averages across recall days. Overall diet quality for both parent and child was assessed three ways: the HEI-2010[17], DASH score[18], and energy density[19].

The HEI-2010 evaluates diet quality in comparison to the 2010 Dietary Guidelines for Americans.[16,17,26] The HEI-2010 score is derived from 12 components, including nine adequacy components (total fruit, whole fruit, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plan proteins, fatty acids), and three moderation components (refined grains, sodium, and empty calories).[17,26] Higher scores for each component represent better diet quality with moderation components thus being reverse scored. HEI-2010 score ranges from 0-100. The DASH score, which measures adherence to the DASH dietary pattern rich in vegetables, fruits, and low-fat dairy products[27] was calculated according to Günther and colleagues[18]. The total DASH score is based on eight food groups (grains, vegetables, fruits, dairy, meat, nuts/seed/legumes, fats/oils, and sweets). There is a maximum component score of 10 for each food group when intake meets recommendations with lower intakes scored proportionately.[28] Reverse scoring is used when lower intakes (e.g, fats/oils and sweets) are favored. Component scores are summed to create the overall DASH adherence score ranging from 0 to 80. Energy density, which is the number of kilocalories per gram of intake was also used to evaluate diet quality with lower ED reflective of a diet richer in foods high in water and fiber, and lower in fat. Emerging evidence suggests lowering ED as an effective means to improved diet quality.[29] Several methods exist for calculating ED[30,31]; however, the calculation using food only, excluding beverages and water, was used. Intake in grams and energy were directly derived from NDS-R software and averaged across days for the child and parent individually.

Analysis

Parent-child dyads with at least two days of dietary intake were included in analyses. Less than 1.5% of the population had only two days, with the remaining having three days. First, paired t-tests were used to compare all diet quality measures and energy intake between parents and children. Next multiple linear regression models in Mplus Version 7.3 (Muthén & Muthén, 1998-2012) were used to examine if parent diet quality (HEI-2010, DASH score, and ED) predicted child diet quality (HEI-2010, DASH score, and ED, respectively), and if parent energy intake predicted child energy intake after controlling for parent characteristics (sex, BMI, age, race/ethnicity), child characteristics (sex, BMI z-score, age, race/ethnicity), household education (no college, some or college graduate, graduate or professional degree) and neighborhood type. Unstandardized and standardized beta coefficients were reported and a p-value less than 0.05 (two-tailed) were considered significant a priori.

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Results

Parent and child demographics and anthropometrics are presented in Table 1

Diet Quality

Parent diet quality was significantly better than child diet quality in terms of total HEI-2010, DASH, and ED scores (Table 2). All HEI-2010 and DASH components scores also significantly differed between parent and child, except for whole grains in HEI-2010 and meat, poultry, fish, egg in DASH. On average parents achieved 64.5% and 56.6% of the maximum HEI-2010 and DASH score, respectively. The percent maximum achieved by children was slightly lower, with values at 58.3% for HEI-2010 and 54.3% for DASH.

Across all diet quality measures parent diet quality significantly predicted child diet quality for HEI-2010, DASH score and ED (Table 3). The total amount of variance accounted for from child characteristics, household education, neighborhood-type and parent diet quality on child diet quality ranged from 14 to 17%. In addition, parent diet quality contributed an extra 15.2%, 10.6%, and 10.2% to explaining variance in children's HEI-2010, DASH, and energy density, independent of the other factors in the models, with these values representing the semi-partial r-squared value for the parent diet quality term.

Energy

On average children consumed 1751 ± 431 kcal/day, which was not significantly different than the 1763 ± 524 kcal/day consumed by parents. As shown in Table 3 parent energy intake (adjusted for demographics and neighborhood-type) significantly explained child energy intake (standardized beta [β] = 0.295, $p < 0.001$). Parent energy explained 9.2% of the variance in children's energy intake independent of the other factors in the model, with the full model also including demographics and neighborhood type accounting for 21% of child energy intake variance.

Discussion

This investigation examined the relationship between parent and child diet quality and energy intake, from nearly 700 parent-child dyads. Parent diet quality, adjusted for parent and household characteristics and neighborhood-type, significantly predicted child diet quality as calculated using HEI-2010, DASH, and energy density. After adjustments parent diet quality variables were consistently the strongest independent predictors of child diet quality in these models. Similar outcomes were found for the relationship between parent and child energy intake. While previous studies have investigated relationships between parent and child dietary intake, adjustments have not been made for confounding demographic and environmental variables, thus these strong effects demonstrate a more precise estimate of the relationship between parent and child diet quality and energy intake.

While direct comparisons cannot be made due to inconsistent measurement and analysis methodologies, results from the current study suggest a stronger relationship between parent diet quality and child diet quality than that found previously in a nationally-representative study. The previous study assessed diet quality using the HEI-2005 based on only two days of dietary intake in a more diverse population of parents and children 2-18 years-old.[32] One explanation for the stronger parent-child diet quality and energy intake associations found in the current study may be a narrower age range of children (6-12 years) that were included in the NIK cohort compared to a wider age range of children and adolescents in the national study. In general, parents have greater control over food choices in younger children compared to older children and teens.[33] Two studies using the HEI have been conducted in younger children and the results are of a similar magnitude to that found in the current study.[34] Among the prior studies, analyses of father-child dyads found father HEI-2010 was positively associated with child HEI-2010 ($\beta = 0.39$, $p<0.0001$)[35] and analyses of mother-child dyads found mother HEI-2005 positively correlated with child HEI-2005 ($r = 0.44$, $p<0.0001$).[34] It is important to note diet quality in many prior studies[32,34,35] was derived from less than the recommended three 24-hour recalls[15] which were obtained from 98.5% of parent-child dyads included in the current study.

Several interesting findings about the association between parent dietary intake and child dietary intake did emerge. Mean parent energy intake and mean child energy intake were found to be nearly equivalent. As parents assisted children with dietary recalls this may have influenced energy intake as parents have been found to over-estimate energy intake in children compared to child report of their own diet.[36] Further, adults often underreport energy intake on 24-hour recalls as compared to doubly labeled water.[37] Together, over-reporting in children and underreporting in parents may result in similar energy intakes. Due to similar energy intakes, it is not surprising the association between parent energy intake and child energy intake was also significant. Previously, the relationship between parent and child energy intake was shown to be weak to moderate ($r = 0.21$, 95% CI 0.18-0.24) in a meta-analysis.[13]

Not surprisingly, our study indicates that most children were not meeting dietary recommendations, and parents had better diet quality than their children across all measures of overall diet quality and most components of these measures. On average parents had higher scores for vegetables, greens and beans, when calculated using the HEI-2010 and higher scores for total vegetables using the calculated DASH score. Parents also had higher scores, signifying greater adherence to recommendations, than children for the refined grains and extra calories components of HEI-2010, and the fats, oils, and sweets components of DASH. These results confirm under-consumption of vegetables and over consumption of empty calories among children, based on HEI-2010, appear to be major contributing factors to their poorer diet quality. While ED (food-only) was included as a measure of total diet quality of all foods consumed over a day it may better measure diet quality for individual foods (e.g., a piece of fruit, macaroni and cheese, etc.). Energy density scores were consistent with HEI-2010 and DASH such that children had poorer diet quality than their parents. However, the respective energy density scores of 1.7 and 1.9 for parents and children as found in this study would be classified as low-energy dense[19], indicating a higher diet quality. This interpretation does not appear to be consistent with HEI-2010 and DASH findings.

The present study has several strengths including use of multiple 24-hour recalls for both parents and children and three different diet quality indicators (HEI-2010, DASH, energy

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density). The large sample (n = 698) of parent-child dyads enhanced confidence in the findings; however, they need to be interpreted within the context of the limitations. Limitations include the cross-sectional design of the study, a highly educated sample of mainly mothers, limited ethnic/racial diversity, and representation from only two geographic regions of the US. Future research should investigate the influence of parent diet quality and energy intake on child diet quality and energy intake in more economically and racially/ ethnically diverse populations. Lastly, due to the self-reported nature of dietary data and parents reporting intake for children <8 years of age, self-report bias could have been introduced in addition to the parents' involvement biasing results.[38] Thus, it is possible that the strong association found could be due to parents reporting for themselves and their children.

Conclusions

This cross-sectional study found substantial associations between parent and child scores on diet quality and energy intake, independent of demographic, BMI, and environmental covariates. Although results might be influenced by parents reporting for both members of dyads, these finding suggest the need for research that evaluates interventions targeting parents' eating patterns and observes the impact on the entire family's eating patterns.

Acknowledgments

Funding/Support Disclosure: Research reported in this publication was supported by the National Institute of Environmental Health Sciences under award number R01 ES014240 and the National Institute of Diabetes and Digestive and Kidney Diseases under award number T32DK063929. This project was also supported by the National Research Initiative of the USDA National Institute of Food and Agriculture (2007-55215-17924). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health or USDA.

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Table 1

Demographic and Anthropometric Characteristics of 698 Parent-child Dyads from the Neighborhood Impact on Kid Study Conducted in Kind County, WA and San Diego County, CA

Characteristic	Parent	Child
Age[a] (years), M ± SD[b]	41.5 ± 5.9	9.1 ± 1.6
Sex, n (%)		
Male	98 (14)	344 (49.3)
Female	600 (86)	354 (50.7)
Race/Ethnicity[c], n (%)		
White, Non-Hispanic	588 (88.6)	565 (81.0)
Non-white[d] or Hispanic	76 (11.5)	133 (19.1)
Education[e] (highest level of adult), n (%)		
No college	45 (6.7)	
Some or college graduate	383 (56.9)	
Graduate or professional degree	345 (36.4)	
Weight Status, n (%)		
Not overweight or obese[f]	301 (43.2)	514 (73.7)
Overweight[g]	220 (31.6)	104 (14.9)
Obese[h]	175 (25.1)	80 (11.5)

[a]Sample size for age = 674

[b]M ± SD, mean ± standard deviation

[c]Sample size for race/ethnicity = 664

[d]Non-white includes African American or Black, Asian, Pacific Islander, American Indian or Alaskan Native, other race, and two or more races.

[e]Sample size for education = 673

[f]Defined in adults as a body mass index ≥ 18.5, but <25 and in children as a body mass index percentile ≥5th, but <85th.

[g]Defined in adults as a body mass index ≥ 25, but <30 and in children as a body mass index percentile ≥85th, but <95th.

[h]Defined in adults as a body mass index ≥ 30 kg/m2 and in children as a body mass index percentile ≥95th.

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Table 2

Diet Quality Using HEI-2010, DASH Score, and Energy Density of 698 Parents and Their Child from the Neighborhood Impact on Kids Study

Diet Quality Measure	Score Range[a]	Parent M±SD[b]	Child M±SD[b]	p-value[c]
HEI-2010[d] total score	**0 - 100**	**64.5 ± 13.3**	**58.3 ± 12.1**	**<0.001**
Total fruit	0-5	2.5 ± 1.8	3.1 ± 1.8	<0.001
Whole fruit	0-5	3.1 ± 1.9	3.3 ± 1.8	0.025
Total vegetables	0-5	4.6 ± 0.9	3.3 ± 1.5	<0.001
Greens and beans	0-5	2.6 ± 2.1	1.2 ± 1.7	<0.001
Whole grains	0-10	5.3 ± 3.5	5.1 ± 3.3	0.067
Dairy	0-10	6.7 ± 2.8	8.3 ± 2.2	<0.001
Total protein foods	0-5	4.6 ± 0.9	4.0 ± 1.1	<0.001
Seafood and plant proteins	0-5	3.5 ± 1.9	2.8 ± 2.0	<0.001
Fatty acids	0-10	4.6 ± 3.2	3.2 ± 2.7	<0.001
Sodium	0-10	4.4 ± 3.1	5.1 ± 3.0	<0.001
Refined grains	0-10	6.6 ± 3.1	5.3 ± 3.2	<0.001
Empty calories	0-20	16.0 ± 3.7	13.7 ± 3.8	<0.001
DASH[e] total score	**0 - 80**	**45.3 ± 10.2**	**43.4 ± 9**	<0.001
Total grains	0-5	4.3 ± 1.0	4.9 ± 0.4	<0.001
Whole grains	0-5	2.7 ± 1.6	3.1 ± 1.6	<0.001
Vegetables	0-10	6.5 ± 2.7	4.7 ± 2.9	<0.001
Fruits	0-10	3.8 ± 3.1	6.4 ± 3.4	<0.001
Total dairy	0-5	3.0 ± 1.4	4.0 ± 1.2	<0.001
Low-fat dairy	0-5	1.2 ± 1.5	1.5 ± 1.7	<0.001
Meat, poultry, fish, eggs	0-10	9.7 ± 1.1	9.6 ± 1.4	0.1727
Nuts, seeds, legumes	0-10	5.3 ± 4.4	3.1 ± 4.0	<0.001
Fats, oils	0-10	5.4 ± 4.2	4.4 ± 4.4	<0.001
Sweets	0-10	3.3 ± 4.3	1.6 ± 3.3	<0.001
Energy density (kcal/g[f])				
Food only		1.7 ± 0.4	1.9 ± 0.4	<0.001

[a]Intakes between the minimum and maximum are scored proportionally.

[b]M±SD, mean ± standard deviation

[c]P-values indicate significance of differences between parent and child dietary variables.

[d]HEI-2010, Healthy Eating Index-2010

[e]DASH, Dietary Approaches to Stop Hypertension

[f]kcal/g, kilocalories per gram

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Table 3

Linear Regression Model Quantifying the Influence of Parent Diet Quality and Energy Intake on Child Diet Quality and Energy Intake by Controlling for Child Characteristics, Highest Household Education, Neighborhood-Type in a Sample of 698 Parent-Child Dyads from the Neighborhood Impact on Kids Study

	Child Diet Quality Scores									Child Energy		
Independent Variables	**HEI-2010[a]**			**DASH[b] Score**			**Energy Density[c]**			**kcal[d]**		
	B (β)[e]	**SE[f]**	**p-value**	**B (β)[e]**	**SE[f]**	**p-value**	**B (β)[e]**	**SE[f]**	**p-value**	**B (β)[e]**	**SE[f]**	**p-value**
Child sex[g] (female)	0.84 (0.04)	0.81	0.30	0.67 (0.04)	0.62	0.28	-0.12 (-0.15)	0.03	<0.001	-238.08 (-0.28)	28.70	<0.001
Child BMI[h] z-score	0.04 (0.00)	0.45	0.94	-0.28 (-0.03)	0.32	0.38	-0.02 (-0.04)	0.01	0.26	32.59 (0.08)	15.25	0.03
Child age	-0.66 (-0.09)	0.27	0.02	-0.58 (-0.10)	0.20	<0.01	-0.01 (-0.02)	0.01	0.59	22.34 (0.08)	8.82	0.01
Highest household education	0.83 (0.04)	0.68	0.22	0.59 (0.04)	0.52	0.26	-0.01 (-0.02)	0.03	0.66	75.41 (0.11)	23.31	<0.01
Child race[i] (non-White)	-0.00 (0.00)	1.03	1.00	-0.19 (-0.01)	0.84	0.83	-0.11 (-0.10)	0.04	<0.01	-62.48 (-0.06)	34.97	0.07
High PA/high NE[j]	-1.77 (-0.07)	1.12	0.12	-1.29 (-0.06)	0.88	0.14	0.02 (0.02)	0.04	0.57	-17.24 (-0.02)	40.69	0.67
High PA/low NE[j]	-2.32 (-0.09)	1.09	0.03	-1.59 (-0.08)	0.86	0.07	-0.00 (-0.00)	0.04	0.99	-71.41 (-0.07)	40.27	0.08
Low PA/high NE[j]	-1.16 (-0.04)	1.15	0.32	-0.50 (-0.02)	0.87	0.56	-0.05 (-0.05)	0.04	0.26	-71.86 (-0.07)	40.80	0.08
Parent Diet Quality[k]	**0.34 (0.39)**	**0.03**	**<0.001**	**0.28 (0.33)**	**0.03**	**<0.001**	**0.31 (0.32)**	**0.04**	**<0.001**	----		
Parent Energy Intake[k]	----			----			----			**0.24 (0.30)**	**0.03**	**<0.001**
R2	**0.17**			**0.13**			**0.14**			**0.21**		

[a]HEI-2010, Healthy Eating Index-2010

[b]DASH, Dietary Approaches to Stop Hypertension

[c]Energy density is food only

[d]kcal, kilocalories

[e]B, unstandardized coefficient; (β), standardized coefficient

[f]SE, standard error for the unstandardized beta coefficient (B)

[g]The reference for gender is male.

[h]BMI, body mass index

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[i] The reference for race is White.

[j] PA, physical activity; NE, nutrition environment; the reference for neighborhood type is low PA/low NE.

[k] Parent diet quality and energy intake were adjusted for by parent characteristics (gender, BMI, age, race/ethnicity), highest household education, and neighborhood type.