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Associations between Household- and Child-Referenced Food Security Status and Dietary Intake among Low-Income Urban Black Children

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Abstract

We examined whether dietary intake differs across household and child food security (FS) status, and Supplemental Nutrition Assistance Program (SNAP) participation among Black children (ages 9-15) in a low-income urban setting. This cross-sectional survey used the USDA 18-item Household Food Security Survey, that includes the 8-item Child Module, and a validated FFQ to assess children's diet (n=451). Nutrient intake differed across child FS status, but not household FS. SNAP participation was associated with better micronutrient intake (vitamin D and calcium) among food secure children. Assessing child-specific FS and nutrient adequacy clarifies children's actual experience and informs child-targeted policies.

Keywords

Food Insecurity; Black; Child; Diet; Food Assistance; Micronutrients

1. Introduction

Racial and ethnic inequalities in food security status in the United States are of significant concern, with Black and Latin American populations significantly more likely to be food insecure than white populations.[1] In 2017, there were 41.9% of Black households experiencing food insecurity compared with 31.8% of White non-Hispanic households.[2] Across all racial and ethnic categories, household food insecurity was estimated at 15.7% among U.S. families with children.[2] In some food insecure households, adults attempt

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to buffer children from dietary compromise, for instance, decreasing the amount, variety, and quality of foods they consume, before decreasing the amount of food available to the child.[3,5]

The impact of food insecurity on children's health may be through both nutrition and/or non-nutrition (i.e. anxiety/stress) pathways.[5,6] The nutrition pathway suggests that in the absence of adequate and healthy food supplies (e.g., types, quality, and amount), families may rely on low cost, long shelf-life, and high-energy dense foods that are low in micronutrients (e.g., noodles), and they may binge when food is available.[7] These food-choice coping strategies increase the risk of nutritional deficiencies, weight gain, and affect growth and development of children and adolescents.[8-11] Thus, dietary behaviors may mediate the association between food insecurity and weight gain among socioeconomically disadvantaged youth.[11] Jun et al. observed food insecurity in childhood to be associated with lower micronutrient adequacy but not overall dietary quality.[8] However, when examining the association between food insecurity and diet among children, most studies have utilized measures reflecting household food security, not focusing specifically on child food security status.[3]

The Supplemental Nutrition Assistance Program (SNAP), has been one of the most important nutrition assistance programs in the U.S. for low-income households aiming to attenuate food insecurity.[12] Nearly 40 million individuals participated in SNAP in an average month of 2018, and although its impact on reducing hunger and food insecurity has been observed, the impact of the program on diet quality and micronutrient intake is mixed.[12-14] However, most studies assessing the association between SNAP participation and diet have focused on the adult population[13] and young children[15], with little evidence regarding the nutritional impact on school-aged children.[16] SNAP participants report allocating SNAP assistance for their children and families[17], suggesting the potential impact of the program on children's learning and health, which may be particularly noteworthy among vulnerable populations.[18]

Although in the United States, Non-Hispanic Blacks have disproportionally higher rates of obesity and food insecurity than Hispanic and non-Hispanic White populations[1,2], few studies have assessed the association between child food security and dietary intake.[10] Child food security is measured as part of the the U.S. Department of Agriculture 18-item Household Food Security Survey in the Child-reference Module concerning caregivers' experiences of providing food to children in their households[19], and it has been proven to be a sensitive approach to detect differences in exposure to nutrients.[8] Most of previous research on food insecurity among children has been conducted among high risk populations suffering disproportionately higher rates of food insecurity; however, few examine its relation to dietary intake among Black populations.[8] Thus, this paper addresses this limitation and examines the association between food security and dietary intake among low-income Black children in a Northeast region of the U.S. More specifically, we aimed to assess whether dietary intake (macronutrients and micronutrients) differ by the level of household and child food security status; and to evaluate if child dietary intake varies between food security level and SNAP participation.

2. Methods

2.1. Study Design and participants

This was a cross-sectional analysis using baseline data from a childhood obesity prevention intervention conducted in 30 low-income neighborhoods in Baltimore City, Maryland, U.S. – *B'more Healthy Communities for Kids*.[20] The intervention targeted low-income Black youth and their families and aimed to increase the demand for and access to healthier and affordable foods through integrated actions at multiple levels of the food and social environments: policy; food supply (wholesalers); retail (corner stores, carry-out restaurants); community (recreation centers); and individual (children and caregivers).

Baseline data were collected from June 2013 to June 2014 (wave 1) and from April to November 2015 (wave 2). The recruitment of the participants occurred at recreation centers (center point) and neighborhoods sites within each 1.5-mile buffer zone. Family eligibility criteria were as follow: 1) having at least one youth aged 9–15 years; 2) living in the same location for at least one month; and 3) not anticipating a move in the next two years. Weight status was not an eligibility criteria. We collected information on demographics, anthropometrics, child dietary intake and food security status through surveys conducted in households of 466 adult caregiver-youth dyads. Youth were excluded from our analysis if they reported consuming fewer than 500 kcal/day or over 7,000 kcal/day (n=12)[21] and if the primary caregiver reported living in a shelter (n=3). The analytical sample consisted of 451 youth.

The study was approved by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board. Caregivers provided consent for their child to participate and youth provided written assent. Families received a gift card for their participation.

2.2. Measures

Youth Dietary Data: Dietary intake was measured using the Block Kids 2004 Food Frequency Questionnaire (BKFFQ).[22] The BKFFQ instrument is a semi-quantitative, validated questionnaire in adolescent populations[22,23] that ascertains previous week's frequency (from 'none' to 'every day') and consumption amount of 77 common food items (with three to four categories related to food type). It contains foods identified by NHANES II commonly consumed by youth. To aid with dietary intake recall and portion size estimates, bowls, plates, cups, and glasses of various sizes were used to minimize response bias. Food frequency questionnaires are recommended in population-based studies to estimate habitual intake[24] and to evaluate long-term dietary intake patterns.[25] Validation studies using Pearson's correlation coefficients have shown that food frequency questionnaires adequately estimate energy, macronutrients[22], and micronutrients for children.[26] The nutrients included in our analyses were selected on the basis of their significance for children's health and are frequently under or overconsumed: macronutrients (carbohydrate, protein, total fat, fiber, and added sugar) and micronutrients (vitamin B12, vitamin D, calcium, iron, zinc, and sodium).

Completed BKFFQs were analyzed by Nutrition Quest (Berkley, California, USA) and estimates of food and nutrition intakes were generated for each youth. The estimated mean intake of macro- and micronutrients was compared to the adherence to appropriate Dietary Reference Intake (DRI). For all the studied micronutrients (except for sodium), adequacy was calculated based on the Estimated Average Requirement (EAR), the percentile of the usual intake distribution below the sex- and age-specific EAR was used to estimate the percentage of participants at risk of inadequacy. For sodium intake was considered the Adequate Intake (AI). Macronutrients were expressed as a percentage of total energy intake, and adequacy was analyzed according to the Acceptable Macronutrient Distribution Range (AMDR). For added sugars, the American Heart Association recommendation is ≤ 25g per day for children.[27] The adequacy of energy intake was not estimated, as information on physical activity level was not collected in this study.

Vitamins and minerals from supplements were not counted towards the average daily dietary intake presented in our analyses, as they were calculated separately from those obtained from food. Fifteen percent (n=76) reported having taken any multi-vitamin pills in the past seven days.

Household and Child Food Security Status: We assessed food security status using the 18-item Household Food Security Survey (USDA).[28] This is a self-reported survey that assesses worry about accessing food in terms of quantity, quality and variety experienced by the caregiver, or another adult or child in the household in the past 12 months, answered by the primary caregiver. The instrument has a five-stage screener process, in which items that were not applicable to the respondent were skipped because they have not experienced the condition represented in the question. Household food security was coded using recommended cut-poins for household-referenced questions, ranging from 0 to 18 points: very low (eight or more affirmatives); low (three to seven); marginal (two to one); high (none). The child food security status, related to child-referenced questions, ranged from 0 to 8 points and was coded as following: very low (five or more affirmatives); low (two to four); high or marginal (one or none). Due to the low prevalence of children in our sample classified in the very low group (2.4%), the low and very low child-referenced food security groups were combined in our analyses.

Demographics: Sociodemographic characteristics were collected as part of the baseline assessment of the parent study.[20] Children reported their age and sex, and their primary caregivers reported on demographics and household socioeconomics: caregiver's age, gender (female, male), marital status, education level (< high school, completed high school, and > high school), employment status (employed, full or part-time, unemployed, or retired), household annual income (<US$20,000; 20,001–30,000 or higher), housing arrangement (owned, rent, and shared with family or other arrangement, such as group housing, transitional housing), number of individuals in the household, number of children (<18 years old) in the household, and food assistance participation: Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) or SNAP in the past year.

Antropometrics: We directly measured weight and height of adults/caregivers and children in the same household, using a Seca 213 Portable Measuring Rod stadiometer and a Tanita BF697W Duo Scale. Respondents were weighed and measured barefoot, in their clothes, removing only heavy outerwear. Body Mass Index (BMI) was obtained by calculating weight/height^2 (kg/m^2). For adults, overweight was defined as BMI between 25.00 and 29.99 kg/m^2 and obesity as BMI greater than or equal to 30.00 kg/m^2, according to the WHO recommendations.[29] BMI for children up to 14 years old was assessed using BMI-for-age, according to the CDC 2000 growth chart. Overweight was defined as a BMI-for-age Z-score ≥1 and <2 and obesity as a BMI-for-age Z-score ≥2 for children of the same age and sex.

2.3. Data Analysis

Differences in sociodemographic factors across the four categories of household food security status were assessed to describe the study population's characteristics, using logistic regression for dichotomous variables and two-sided t-tests for continuous variables. To identify differences in sociodemographic variables across the household-referenced food security status, statistically significant differences for proportions of more than two categories were assessed by Kruskal Wallis test with Dunn’s post hoc test after Bonferroni adjustment.

Linear regression models were performed to compare the mean macro/micronutrient differences across the household-referenced and child-referenced food security groups. Our model specification checks, including assessment of model residuals, revealed that all assumptions were met when the outcomes (all macro/micronutrients) were log-transformed. To improve interpretation of the results, the tables report the non-transformed variables, and the p-values of the linear regression models represent the log-transformed models. Logistic regression analyses were conducted to examine differences in nutrient adequacy between household- and child-referenced food security groups. Linear combination of estimators was used after each regression to calculate differences between the household- and child-referenced food security groups.

For the analyses examining the differences in mean macro/micronutrient intake and nutrient adequancy, we also included a 2-way interaction term between food security status and child sex. No effect modification by child sex was found in the linear or logistic regression in the household-referenced food security status models.

Lastly, we examined if the association between food security status (exposure) and children’s diet in terms of macronutrients and micronutrients (outcome) varied by SNAP status (effect modifier), after controlling for caregiver and child characteristics (sex, age, BMI, educational level). To avoid multiple comparison issues, we performed bootstrapping with 2000 iterations, and examined biases adjusted confidence intervals in all regressions to control the proportion of Type I errors. For all analyses, statistical significance was defined by a *p*-value of <0.05. All statistical analyses were performed using the Stata 14.1 software (College Station, TX, USA).

3. Results

3.1. Description of the study sample

The mean age of children was 11.7 years (SD = 1.4) (Table 1). Forty-two percent of children lived in a low or very low food security household. Household and child food security status were correlated (r = 0.62). Households experiencing low food security had significantly higher proportion of SNAP participation (32.3%) and lower education level of the head of the household (41.7%), when compared to the marginal and high household food security statuses.

3.2. Differences in dietary intake by household food security status

Average child's nutrient intake and adequacy of consumption were not different across the four categories of household food security (Table 2). Overall, dietary fiber, and calcium intake were low among the study sample, with only 9% and 13% of children adhering to dietary guidelines, respectively (Table 2).

3.3. Differences in dietary intake by child food security status

Children in the low or very low child-referenced food security status consumed on average more than 200 kcal/d (mean 1947.3 vs 1722.9 kcal, p=0.04), 4g more of added sugar (21.1 vs 17.1 g, p<0.01), and 0.5% less kcal from protein (p=0.03) than children in high or marginal child-referenced food security status. A greater prevalence of girls in the very low or low child-referenced food security status met recommendations for fiber, vitamin B12, calcium (Table 3) than boys and girls in high or marginal child-referenced food security status.

3.4. Differences in dietary intake by food security status and SNAP participation

Within the child food secure group, children from a household receiving SNAP had greater mean vitamin D and calcium intake, than children not receiving SNAP (Table 4). Based on the child-reference, children in the food insecurity group receiving SNAP had statistically significant lower average added sugar intake than children in the food secure group. A similar pattern was seen regarding fiber and total energy intake, where children in the food insecure group receiving SNAP had a lower average intake than children in the food secure group. No difference in nutrient intake was found among child-referenced food insecure children based on SNAP receipt.

Among children in the household-referenced food insecure category, those who lived in a household participating in SNAP had statistically significant greater average intake of vitamin D than children in households not receiving SNAP. Moreover, average calcium intake was greater among household-referenced food insecurity children participating in SNAP than children in household-referenced food secure without SNAP.

4. Discussion

This study examined macronutrient and micronutrient intake among both child-referenced and household-referenced food security status, and modification by SNAP participation in a sample of low-income Black children. Child food security status allowed us to detect important differences in children’s dietary intake, but not when examining differences by household food security status. This finding corroborates the relevance of assessing food insecurity and nutrient adequacy at child-specific variable levels.[5,8,19,30] Food insecurity referenced at the household-level reflects household resource management; analysis of the 8-item child module is necessary to assess children's actual dietary experiences.[3,19,30]

In the household food security analysis, we observed a low percentage of nutrient adequacy, with less than 30% of children adhering to dietary guidelines for dietary fiber, and calcium. There is no consistent association between household food insecurity and children's poor diet quality, except for lower fruit consumption, which corroborates our result of dietary fiber inadequacy.[3] Even though caregivers in food insecure household may implement coping strategies to feed their children, it is challenging to meet nutrient and dietary needs. Food security and adequate nutrition are influenced by complex factors related to socioeconomic household characteristics, such as family income, number of residents/ children, food assistance participation, social support, and aspects of the neighborhood food environment[3,5,6], which help to explain the challenges that low-income families face in adhering to dietary guidelines.

In this study, using child-referenced food security status, children in the low or very low food security status showed a significantly higher energy and added sugar intake, and lower protein intake than children in high or marginal food security status. Likewise, a recent review provided strong evidence of higher energy intake from added sugar among food insecure children 6–11 years of age compared to food secure children.[10] Factors such as binge eating when food is available at home, lack of cooking practices, and snacking behaviors may be linked to energy dense and highly processed food patterns, in turn, leading children in food insecure conditions to experience excess weight gain.[11]

Diet intake varied significantly by sex, especially total energy intake, fiber, vitamin B12, and calcium. Girls in the low or very-low child-referenced food security group consumed a higher average total energy intake and fiber than boys and girls in the high or marginal child-referenced food security group. The finding that adequacy of micronutrient intake was higher among girls from low or very low child-referenced food security group warrants further investigation as there has been limited research on nutritional disparities by sex in relation to childhood food insecurity.[8]

We found that SNAP participation was associated with greater calcium and vitamin D intake among children. Although vitamin D intake from food and beverage is usually a nutrient of concern, youth in our sample had an overall higher adherence to dietary guidelines for this micronutrient than the national popualtion, and those participating in SNAP had higher average vitamin D intake than non-SNAP. Associations between SNAP participation on calcium intake has remained mixed.[13] However, a cross-sectional analysis using NHANES data with children between 4-19 years old reported a significantly higher calcium intake among SNAP participants than nonparticipants[31], as we found in this study.

A review of the literature reported that youth living in households receiving SNAP obtained adequate calories, but had lower dietary quality compared with youth from non-SNAP households.[13] Associations between SNAP participation within food security status household in relation to children's dietary intake are not causal. A possible explanation for a better dietary intake found in low and very low child food security among SNAP households compared to non-SNAP households can be associated with food environment features. For example, supercenters and supermarkets are the main food venues among SNAP beneficiaries and almost all large retail food sources accept SNAP benefits, which has been associated with healthier food choices when compared to corner stores and prepared food stores that have a lower SNAP acceptance rate.[32] Additionally, access to the SNAP education (SNAP-Ed) program, an evidence-based programming on meal planning and healthy eating strategies that reaches SNAP-eligible families, could explain better dietary intake among SNAP households.

There are several limitations to this study. First, this was a cross-sectional study, and therefore causal inferences cannot be made. Longitudinal studies are needed to assess changes in nutritional intake and food security related to SNAP participation. In addition, our study focused on a low-income Black urban population, which limits the generalizability of the results to other settings. However, given the disproportional higher rates of low diet quality and food insecurity among this population, our study provides important data for public health researchers and policymakers.

An additional limitation of the study is that we used a semi-quantitative 7-day food frequency questionnaire to estimate macro/micronutrient intake. There might be the risk of social desirability bias, with children more willing to report consuming the foods they think are healthy, than unhealthy. However, our instrument (BKFFQ) was validated to assess diet among children and assessment was conducted by trained data collectors, who had established inter-rater reliability to reduce the administrator bias, to ultimately reduce information bias. To further investigate macronutrient and micronutrient adequacy among this population, future studies should employ multiple 24-hour diet recalls. Differences in sample size by sub-groups, especially between SNAP and non-SNAP household within food security groups, may have reduced the power of our analysis to detect differences in intake. Finally, due to the selection bias in receiving SNAP and many unmeasured confounding factors inherent in SNAP participation, our findings should be interpreted with caution.

6. Conclusions

Differences in nutrient intake among youth were observed when using both the child- and household-referenced food security classifications. However, child-referenced food security appears to be more sensitive to nutrient intake among children than the 18-item household module. Future studies should focus on using a food security screener specifically for children and adolescents to better understand their own food security perception and dietary intake. We found that children in SNAP-participating households had greater micronutrient intake (calcium and vitamin D) and lower total energy intake (kcal) than children from families not participating in SNAP, indicating that food assistance participation might play a protective role in Black children's diet in the context of household and child food security. Longitudinal studies collecting multiple measures of food security and diet intake (multiple 24h dietary recalls) should be conducted to better examine these associations. Children living in households that are food insecure are more vulnerable to poor nutritional and developmental outcomes, thus efforts and policies such as SNAP are essential and should be strengthened to ensure that all eligible families receive these benefits.

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Data Availability:

The data that support the findings of this study are available from the corresponding author, ACBT, upon reasonable request.

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Table 1.

Characteristics of the youth and their households (n=451)

	Household Food Security Status			
	High (n=144) 31.9%	**Marginal (n=116) 25.7%**	**Low (n=139) 30.8%**	**Very low (n=52) 11.5%**
Youth				
Sex: female (%)	30.5	25.0	32.0	12.5
Mean age in years (SD)	11.6 (1.4)	11.7 (1.5)	11.7 (1.4)	11.7 (1.4)
Mean BMI z-score (SD)[1]	1.0 (1.1)	0.9 (1.0)	0.9 (0.9)	1.0 (0.9)
Child food security status (%)[2]				
High or Marginal	40.4	31.8	26.1	1.6
Low	0	2.4	53.6	44.1
Very low	0	0	0	100.0
Caregiver				
Gender: female (%)	31.5	25.4	31.0	12.2
Mean age in years (SD)	40.7 (10.7)	38.1 (8.4)	38.7 (8.8)	39.1 (9.3)
Mean BMI (kg/m^2) (SD)[1]	33.3 (7.6)	33.7 (7.2)	33.4 (8.6)	34.3 (7.8)
Overweight or Obese (%)	32.1	26.4	29.8	11.6
Marital status: married (%)[3]	35.6	26.9	26.9	10.6
Education level (%)				
< High school [a]	20.2	25.3	41.7	12.6
High school [b]	30.8	31.3	27.0	10.8
> High school [b]	38.0	20.5	29.5	12.0
Employment status (%)				
Employed (full- or part-time)	36.4	26.1	29.2	8.3
Unemployed	25.8	25.8	33.7	14.6
Retired	54.5	0	18.2	27.3
Household				
Mean household size (SD)	4.7 (1.7)	4.5 (1.5)	4.6 (1.6)	4.5 (1.9)
Mean number of children (< 18 years old) in the household (SD)	2.7 (1.5)	2.6 (1.3)	2.7 (1.4)	2.5 (1.6)
Annual income <20,000 US$ (%)	27.3	24.4	34.0	14.3
Income to poverty ratio < 1.0 (%)[4]	26.2	25.8	34.9	13.1
Food assistance participation (%)[5]				
SNAP	29.1	26.2	32.3[*]	12.3
WIC	37.2	27.4	26.5	8.8
Housing arrangement (%)				
Living w/ family or other [a]	27.9	23.2	37.2	11.6
Rented [a]	27.8	26.8	32.9	12.5
Owned [b]	45.3	24.5	21.7	8.5

Abbreviations: SD (standard deviation); BMI (Body Mass Index); SNAP (Supplemental Nutrition Assistance Program); WIC (Special Supplemental Nutrition Program for Women, Infants, and Children)

%: Presented in row percentages

[1] BMI z-score calculate using age- and sex-specific WHO reference for children; BMI calculated as kg/m^2 and classified as overweight or obese if >24.9 kg/m^2 for adult caregivers.

[2] Pairwise correlation coefficient between child food security status and household food security status = 0.62

[3] Self-reported marital status: married or not married (i.e. never married, separated, divorced, or widowed).

[4] Source: U.S. Census Bureau, Weighted Average Poverty Thresholds, 2017.

[5] Food assistance participation in the past 12 months; one household with missing data (n=450)

[a,b] Different letters stand for statistically significant differences (Kruskal Wallis test with Dunn's post hoc test with Bonferroni adjustment or linear regression)

[*] Statistical difference detected for proportions via logistic regression analysis

Table 2.

Youth's nutrient intake and adherence to nutritional requirements by household food security status.

Nutrient	Household Food Security Status[¥]								Between-group difference [1]	Overall sample adequacy % (n)
	High (n=144)		Marginal (n=116)		Low (n=139)		Very low (n=52)			
	Mean (SD)[†]	Adequacy % (n) [‡]	Mean (SD) [†]	Adequacy % (n) [‡]	Mean (SD)[†]	Adequacy % (n) [‡]	Mean (SD)[†]	Adequacy % (n) [‡]		
Macronutrients										
Energy (kcal)[2]	1677.4 (1059.9)	-	1766.1 (993.3)	-	1838.3 (1067.9)	-	1845.9 (1069.2)	-	0.46	-
Carbohydrate (% kcal)	54.7 (6.5)	90.3 (130)	55.4 (7.1)	87.9 (102)	55.1 (6.5)	87.1 (121)	54.4 (5.5)	94.2 (49)	0.82	89.1 (402)
Protein (% kcal)	13.1 (2.1)	93.7 (135)	12.9 (2.3)	91.4 (106)	12.8 (2.1)	89.2 (124)	12.9 (2.2)	88.4 (46)	0.91	91.1 (411)
Fat (% kcal)[3]	34.2 (5.3)	50.7 (73)	33.5 (5.2)	55.2 (64)	34.1 (5.2)	53.2 (74)	34.5 (4.6)	57.7 (30)	0.64	53.4 (241)
Fiber (g)	13.6 (8.9)	7.6 (11)	14.7 (9.5)	9.5 (11)	15.6 (9.8)	10.8 (15)	15.2 (11.0)	9.6 (5)	0.46	9.3 (42)
Added sugar (g)[4]	17.5 (13.6)	81.9 (144)	17.4 (12.1)	80.2 (93)	18.3 (12.6)	76.9 (107)	19.3 (14.3)	80.7 (42)	0.57	79.8 (360)
Micronutrients[5,6]										
Vitamin B12 (mcg)	3.5 (0.1)	85.4 (123)	3.5 (0.1)	85.3 (99)	3.5 (0.1)	87.1 (121)	3.5 (0.1)	84.6 (52)	0.71	85.8 (387)
Vitamin D (IU)	112.6 (4.7)	97.9 (141)	118.1 (6.1)	96.5 (112)	123.2 (5.5)	99.3 (138)	118.1 (11.2)	98.1 (51)	0.45	98.0 (442)
Calcium (mg)	665.1 (15.6)	11.8 (17)	685.8 (16.9)	13.8 (16)	692.9 (13.1)	15.8 (22)	676.2 (31.9)	11.5 (6)	0.23	13.5 (61)
Iron (mg)	12.5 (0.2)	86.8 (125)	12.4 (0.2)	84.5 (98)	12.6 (0.2)	87.8 (122)	12.3 (0.3)	80.7 (42)	0.58	85.8 (387)
Zinc (mg)	9.0 (0.1)	51.4 (74)	8.9 (0.1)	54.3 (63)	8.9 (0.1)	59.7 (83)	8.9 (0.3)	55.7 (29)	0.72	55.2 (249)
Sodium (mg)	2599.6 (38.9)	21.5 (31)	2640.9 (51.7)	22.4 (26)	2611.1 (37.3)	19.4 (27)	2576.1 (86.7)	21.1 (11)	0.47	21.1 (95)

[1]One-way ANOVA analysis

[2]Adequacy of energy intake was not estimated, as information on physical activity level was not collected

[3]When fat is not adequate, intake is above 35%

[4]when added sugar is not adequate, intake is above 25g (AHA, 2016)

[5]Controlled for total dietary intake (centered at the mean: 1769.2)

[6]Adequacy calculated based on the sex- and age-specific Estimated Average Requirements (EAR) for all micronutrients, except for sodium Adequate Intake (AI).

[¥]Measured with the USDA 18-item survey

[†]no statistically significant difference between the groups using linear combinations of estimators

‡ no statistically significant difference between the groups using logistic regression analysis

Table 3.

Youth's average and adherence of macronutrient and micronutrient intake requirements by child food security status using the 8-item child-referenced module.

	Child food security status			
Macronutrients	**Average intake: Mean (SD)**		**% Adequacy (n)[1,2]**	
	High or Marginal (n=358)	**Low or Very Low (n= 93)**	**High or Marginal (n=358)**	**Low or Very Low (n= 93)**
Energy (kcal)	1722.9 (1018.2)[a]	1947.3 (1133.3)[b]	-	-
Boys	1801.0 (79.7)[a]	1580.1 (167.7)[a]	-	-
Girls	1653.9 (74.9)[a]	2201.0 (139.4)[b]	-	-
Carbohydrate (% kcal)	55.7 (6.6)	55.8 (6.1)	89.3 (150)	92.1 (35)
Protein (% kcal)	13.0 (2.1)[a]	12.5 (2.1)[b]	92.8 (156)	86.8 (33)
Fat (% kcal)[3]	34.1 (5.2)	33.7 (5.1)	55.9 (94)	60.5 (23)
Fiber (g)	14.2 (9.2)	16.5 (11.2)	8.1 (29)[a]	13.9 (13)[b]
Boys	14.5 (0.7)[a]	12.1 (1.5)[a]	7.7 (13)[a]	0 (0)[a]
Girls	13.9 (0.7)[a]	19.5 (1.3)[b]	8.5 (16)[a]	23.6 (13)[b]
Added sugar (g)[4]	17.1 (12.3)[a]	21.1 (14.9)[b]	81.5 (291)	73.4 (69)
Micronutrients [5,6]				
Vitamin B12 (mcg)	3.5 (0.1)	3.5 (0.1)	89.8 (151)	76.3 (29)
Boys	3.6 (0.1)[a]	3.6 (0.1)[a,b]	88.9 (64)[a]	84.2 (48)[b]
Girls	3.4 (0.1)[b]	3.2 (0.1)[b]	82.6 (157)[b]	90.9 (50)[a,b]
Vitamin D (IU)	115.1 (3.7)	123.2 (5.5)	97.8 (350)	98.9 (92)
Calcium (mg)	674.7 (11.4)	692.9 (13.1)	12.8 (46)	16.1 (15)
Boys	713.8 (14.7)[a]	712.4 (32.4)[a]	16.6 (28)[a,b]	7.9 (3)[a,b]
Girls	655.1 (11.1)[b]	641.4 (30.8)[b]	9.5 (18)[a]	21.8 (12)[b]
Iron (mg)	12.1 (7.2)	12.6 (0.2)	86.8 (310)	82.8 (77)
Zinc (mg)	8.7 (5.3)	8.9 (0.1)	54.2 (194)	59.2 (55)
Sodium (mg)	2546.6 (1503.1)	2611.1 (37.3)	21.5 (77)	19.4 (18)

[1] Adequacy of energy intake was not estimated, as information on physical activity level was not collected

[2] Adequacy calculated based on the sex- and age-specific Estimated Average Requirements (EAR) for all micronutrients, except for sodium (Adequate Intake (AI)). Source: Dietary Reference Intakes. Presented in row percentages

[3] When fat is not adequate, intake is above 35%

[4] when added sugar is not adequate, intake is above 25g (AHA, 2016)

[5] Controlled for total dietary intake (centered at the mean: 1769.2)

[6] Adequacy calculated based on the sex- and age-specific Estimated Average Requirements (EAR) for all micronutrients, except for sodium Adequate Intake (AI).-- No effect modification by sex

[a,b,c] different superscript letters were statistically significant different (p<0.05) using linear regression analysis

Table 4.

Association between macronutrient and micronutrient intake and food assistance participation among food insecure and food secure children.

	Child Food Insecure			Child Food Secure		
Macronutrients	**Non-SNAP (n=24)**	**SNAP (n=69)**	**Difference**	**Non-SNAP (n=95)**	**SNAP (n=262)**	**Difference**
	Mean (SE)	**Mean (SE)**	**b (p-value)**	**Mean (SE)**	**Mean (SE)**	**b (p-value)**
Energy (kcal)	878.5 (591.2)[a,b]	1257.2 (544.0)[b]	378.7 (0.4)	1967.1 (279.5)[a]	1990.2 (258.2)[a]	23.1 (0.5)
Carbohydrate (% kcal)	53.1 (3.4)	52.5 (3.0)	−0.5 (0.8)	56.5 (1.8)	56.7 (1.7)	0.2 (0.8)
Protein (% kcal)	12.3 (1.0)[b]	13.0 (1.1)[a,b]	0.7 (0.1)	13.1 (0.6)[a]	12.8 (0.5)[a]	−0.3 (0.2)
Fat (% kcal)	36.4 (2.8)	36.1 (2.5)	−0.3 (0.9)	32.1 (1.4)	32.4 (1.3)	0.4 (0.6)
Fiber (g)	5.8 (5.7)[a,b]	10.2 (2.5)[b]	4.3 (0.2)	16.5 (2.5)[a]	16.9 (2.3)[a,b]	0.4 (0.4)
Added sugar (g)	6.4 (7.9)[a,b]	8.4 (7.1)[b]	1.9 (0.8)	17.1 (3.4)[a]	17.6 (3.2)[a]	0.6 (0.6)
Micronutrients [1]						
Vitamin B12 (mcg)	2.7 (0.6)	3.1 (0.6)	0.3 (0.4)	3.5 (0.3)	3.6 (0.2)	0.1 (0.2)
Vitamin D (IU)	59.1 (42.9)[a,b]	67.1 (38.3)[a,b]	8.0 (0.3)	93.7 (16.5)[b]	114.5 (15.2)[a]	**20.8 (0.04)**
Calcium (mg)	592.9 (112.2)[a,b]	606.2 (100.3)[a,b]	13.3 (0.9)	637.6 (47.5)[b]	678.7 (43.9)[a]	**41.1 (0.04)**
Iron (mg)	13.2 (1.4)	13.7 (1.2)	0.4 (0.3)	13.5 (0.5)	13.4 (0.5)	−0.1 (0.7)
Zinc (mg)	8.8 (1.1)	9.2 (0.9)	0.4 (0.8)	9.2 (0.4)	9.2 (0.4)	0 (0.3)
Sodium (mg)	2498.1 (293.7)	2650.0 (262.5)	151.9 (0.8)	2922.9 (135.3)	2824.2 (125.1)	−98.7 (0.6)
	Household Food Insecure			**Household Food Secure**		
Macronutrients	**Non-SNAP (n=43)**	**SNAP (n=148)**	**Difference**	**Non- SNAP (n=76)**	**SNAP (n=183)**	**Difference**
Energy (kcal)	1528.5 (398.2)	1773.5 (345.9)	245.1 (0.3)	1836.5 (341.1)	1787.3 (326.9)	−49.2 (0.8)
Carbohydrate (% kcal)	54.5 (2.3)	53.3 (1.9)	−1.2 (0.3)	57.2 (2.2)	58.2 (2.1)	1.0 (0.2)
Protein (% kcal)	12.9 (0.7)	13.3 (0.6)	0.4 (0.3)	12.9 (0.7)	12.4 (0.7)	−0.5 (0.1)
Fat (% kcal)	34.3 (1.8)	35.2 (1.6)	0.8 (0.3)	31.5 (1.7)	31.2 (1.6)	−0.3 (0.6)
Fiber (g)	13.4 (3.7)	15.3 (3.2)	1.9 (0.4)	14.9 (3.1)	15.2 (2.9)	0.3 (0.5)
Added sugar (g)	9.8 (4.8)	11.5 (4.2)	1.7 (0.4)	19.2 (4.3)	19.5 (4.1)	0.3 (0.9)
Micronutrients [1]						
Vitamin B12 (mcg)	3.4 (0.4)	3.7 (0.3)	0.3 (0.1)	3.4 (0.3)	3.3 (0.3)	−0.1 (0.6)
Vitamin D (IU)	88.5 (25.5)[a]	114.3 (22.1)[b]	**25.8 (0.01)**	85.7 (19.9)[a]	98.8 (19.1)[a,b]	13.1 (0.3)
Calcium (mg)	663.5 (64.2)[a,b]	701.2 (55.7)[a]	13.3 (0.2)	605.5 (61.2)[b]	633.8 (58.4)[a,b]	28.4 (0.2)
Iron (mg)	13.7 (1.4)	13.7 (0.7)	0 (0.7)	13.3 (0.7)	13.3 (0.7)	0 (0.7)
Zinc (mg)	9.6 (0.6)	9.9 (0.5)	0.2 (0.4)	8.8 (0.5)	8.7 (0.5)	−0.1 (0.7)
Sodium (mg)	2769.4 (183.1)	2800.3 (158.8)	30.8 (0.8)	2930.8 (169.3)	2819.5 (161.6)	−111.2 (0.5)

Abbreviations: SE (standard error); SNAP (Supplemental Nutrition Assistance Program), n = 450.

All models controlled for child's sex (male=0, female=1) and age (centered at the mean 11.7), child BMI z-score (continuous) caregiver's BMI (continuous, kg/m2) and education level (less than high school=0, completed high school=1, above high school degree=2).

[1] Micronutrient consumption was adjusted for child's total daily energy intake.

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Child Food Insecure = very low and low food security among children; Child Food Secure = high or marginal food security among children, as defined with the Child-referenced module within the 18-item Household Food Security Survey (USDA, ERS)

Household Food Insecure = Low and very low food security among the household; Household Food Secure = High and marginal food security among the household, as defined with the 18-item Household Food Security Survey (USDA, ERS)

Difference: with SNAP minus without SNAP; **Bolded** values represent statistically significant difference between with and without SNAP within the same food security status.

[a,b]different superscript letters were statistically significant different ($p<0.05$) using linear regression analysis across the four categories.