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Assessing diet quality in a racially and ethnically diverse cohort of low-income toddlers

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Abstract

Background: Low-income racially and ethnically diverse children are at higher risk for obesity compared with their counterparts; yet, few studies have assessed their diet quality.

Objective: To evaluate the diet quality of a racially and ethnically diverse cohort of 2-year-olds using the Healthy Eating Index (HEI)-2010.

Methods: We used 24-hour dietary recall data from caregivers of toddlers (24–34 months) at 4 pediatric resident clinics that participated in the Greenlight Study to calculate compliance with the Dietary Guidelines for Americans (DGA) using total HEI score (range 0–100) and 12 component scores.

Results: Participants (n=231) were mostly Hispanic (57%) or non-Hispanic black (27%) and from low-income families. Mean HEI-2010 score was 62.8 (SD 10.5). Though not significant, Hispanics had the highest HEI score. Toddlers of caregivers without obesity, older than 35 years and born outside the U.S. had higher HEI scores. Most had high HEI component scores for dairy, fruit, and protein foods, but few achieved maximum scores, particularly for whole grains (13%), vegetables (10%), and fatty acid ratio (7%).

Conclusion: Despite scores reflective of DGA recommendations for fruit, dairy and protein foods, toddlers in this diverse sample had low quality diets as measured by the HEI, driven largely

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by low component scores for whole grains, vegetables and ratio of unsaturated to saturated fatty acids.

Keywords

Childhood Obesity; Child Nutrition; Dietary Patterns; Dietary Guidelines; Diet Quality`

Introduction

National data document an increase in the prevalence of obesity (BMI 95th percentile) among 2- to 5-year-olds with 13.7% considered obese in 2015–2016 compared with 9.3% in 2013–2014.¹ We continue to see disparities among children with obesity, with higher rates among non-Hispanic black and Hispanic children compared with non-Hispanic white and non-Hispanic Asian children. These children with obesity are at increased risk of developing chronic conditions during childhood, having poorer quality of life, remaining obese as adults, and having more severe forms of chronic conditions during adulthood.^{2–4}

Dietary intake drives diet quality, and dietary habits associated with obesity, such as low intakes of fruits and vegetables and high intakes of sugar-sweetened beverages, are emerging during the first two years of life.^{5–7} Many toddlers consume some type of dessert, sweet/savory snack or sugar-sweetened beverage at least once in a day, while a substantial proportion do not consume any fruit or vegetable in a given day.⁸ This is concerning because early established food preferences and eating behaviors track through childhood, potentially setting the stage for poor diet quality and increased risk for obesity.^{9,10}

While consuming certain foods, such as a variety of fruits and vegetables,¹¹ and limiting others, such as sugar-sweetened beverages,¹² is important, evaluating the quality of children's diets as a whole remains critical. Recommendations for optimal diet quality to help achieve and maintain a healthy weight, promote health, and prevent disease for healthy Americans aged 2 years and older exist through the *Dietary Guidelines for Americans* (DGAs).¹³ However, few studies examine diet quality in toddlers and the extent to which their diet aligns with recommendations outlined in the DGAs, and none do so in a diverse, low-income sample.^{14,15}

Given the impact consumption of obesogenic foods can have on later intake, a need for studies examining diet quality during early childhood exists, particularly for those at highest risk for obesity. The objective of this study was to evaluate the diet quality of a racially and ethnically diverse sample of 2-year-olds using data from 24-hour dietary recalls to calculate a Healthy Eating Index (HEI)-2010 score; the HEI is a tool used to assess the extent to which diets are consistent with the DGAs.¹⁶

Methods

Participants

Data for this cohort come from caregiver-toddler dyads who participated in the Greenlight Intervention Study (Greenlight), a cluster randomized obesity prevention trial conducted during the first 2 years of life at 4 U.S. pediatric resident clinics (NC, FL, CA and NY).

Detailed design and methods of Greenlight have been described elsewhere.¹⁷ Beginning September 2012 through August 2014 caregiver-toddler dyads who were enrolled in the original Greenlight intervention study¹⁷ were recruited to participate in two 24-hour multi-pass dietary recalls. Caregiver-child dyads were approached by phone or in-person from all four participating clinics to consent to participate. Participants received \$10 compensation for each recall completed. For this study, only children between 24 and 34 months of age who were not receiving breast milk were included (n=231) to reflect the target population of the DGAs. Currently, the DGAs do not include children receiving breast milk or those aged 0–2 years. All protocols were approved by IRBs at all the sites and all caregivers provided written informed consent.

Dietary intake

To assess the diet, we relied on caregivers as proxy reporters.¹⁸ Toddler dietary intakes were assessed via telephone by trained, bilingual study personnel using computerized 24-hour dietary recalls (24HDR) and the Nutrition Data System for Research (NDSR™) (version 2012; Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN). Caregivers were provided example food charts in English or Spanish, and detailed instructions on how to use the food log in the event the child was attending child/day care or otherwise spending portions of their day away from the caregiver responding. Caregivers were also provided measurement aids to estimate portion size. The 24HDRs were performed on random nonconsecutive days that included one week day and one weekend day. Most 81% (n=188) completed two 24HDRs; however, 17% (n=40) completed only one while 1% (n=3) completed a third recall when assessments were deemed incomplete or implausible (i.e. participant was unable to complete the entire recall at one time).

Diet Quality

To assess diet quality, we used the Healthy Eating Index-2010 (HEI-2010), a tool developed by the U.S. Department of Agriculture and the National Cancer Institute to determine conformance with the 2010 DGAs, which were current at the time of data collection.¹⁶ Data from the 24HDR were averaged and used to calculate HEI-2010 component and total scores. The HEI score consists of 12 components¹⁹, 9 of which assess adequacy of the diet, including 1) total fruit; 2) whole fruit; 3) total vegetables; 4) greens and beans (dark green vegetables and legumes not already counted as protein foods); 5) whole grains; 6) dairy; 7) total protein foods; 8) seafood and plant proteins; and 9) fatty acids, which is a ratio of unsaturated versus saturated fatty acids. The remaining three assess dietary components recommended to consume in moderation: 10) refined grains; 11) sodium; and 12) empty calories (i.e., energy from solid fats, alcohol, and added sugars). For all components, higher scores reflect better diet quality as moderation components are reverse scored. Each component is scored on a density basis, either as a percentage of calories or per 1000 calories allowing use of the HEI for a range of ages and populations - based on quality vs. quantity, i.e. a standard serving size. Summed scores of the 12 components yield a possible total score of 100, with a higher score reflecting greater compliance with the 2010 DGAs.²⁰

Covariates

Socioeconomic and demographic characteristics were measured during participation in Greenlight. Covariates were selected a priori and drawn from the literature to include factors previously associated with child diet: caregiver education, age, income, marital status and obesity (BMI ≥ 30.0), and toddler BMI percentile, race/ethnicity, and sex.^{21–24} Caregiver height and weight were collected at baseline (2 months) and toddler height and weight were measured at the 24-month well-child visit; these data are missing for 9% of toddlers (n=21) who participated in the 24HDR data collection by phone, but were no longer patients at study clinics where anthropometric measurements were completed. We explored specific predictors of diet quality in our analyses, including participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) and household food security status, which was assessed using the 2-item screen derived from the U.S. Department of Agriculture 18-item Household Food Security Survey.²⁵ Given the diversity of our sample, we also included whether caregivers were born in the U.S.

Statistical analysis

Characteristics are summarized as frequencies (%) for categorical variables and means and standard deviations (SD) for continuous variables. HEI-2010 scores were calculated using NDSR output to estimate each component with guidance from the Nutrition Coordinating Center.²⁶ With guidance from the National Cancer Institute, the mean ratio approach was applied to calculate total HEI and HEI component scores, summarized as means and standard deviation (SD).²⁷ We also present the percent of maximum score achieved [(mean score/maximum score) \times 100%], since maximum scores differed for various components and ranged from 5–20. Component scores are reported as medians with interquartile range (IQR) given skewness. A one sample t-test was applied to determine if total HEI scores were significantly different from the maximum score of 100 and Wilcoxon signed-rank test for component scores and their respective maximum scores. Polychoric correlation matrices tested for collinearity among socioeconomic and demographic predictors. No predictors were significantly correlated. We assessed the relationship of each socioeconomic and demographic predictor with HEI score using linear regression, while controlling for participating site. Since this was a cluster randomized trial, by controlling for site, we implicitly control for the intervention received. Percentages of toddlers meeting the maximum score for each HEI-2010 component were calculated. P values <0.05 were regarded as significant. All analyses were conducted using Stata 14 (StataCorp, College Station, TX).

Results

Most toddlers were Hispanic (57%) and non-Hispanic black (27%), from households earning less than \$20,000 per year (64%), and receiving WIC benefits (87%) (Table 1). Although most toddlers (73%) had a healthy weight, 14% had overweight (BMI 85th to $<95^{\text{th}}$ percentile) and 7% had obesity (BMI $\geq 95^{\text{th}}$ percentile). One third of caregivers had obesity (BMI ≥ 30), and the majority (70%) had completed high school. HEI-2010 scores ranged from 37.9 to 93.6; the mean score was 62.8 (SD 10.5) and was significantly lower than the optimal recommended score of 100 (P $<.001$) (Table 2).

Toddlers of caregivers with obesity had lower HEI scores in contrast to those without obesity (60.0 (SD 10.2) vs. 64.6 (SD 10.6), $P=.009$) (Table 1). Toddlers from caregivers born outside the U.S. had higher HEI scores compared to those born in the U.S. (64.9 (SD 10.3) vs. 60.1 (SD 10.3), $P=.007$). Toddlers from caregivers who were married or living with their partner had higher HEI scores in contrast to those who were single, separated/divorced or widowed (64.2 (SD 10.0) vs. 59.8 (SD 10.8), $P=.005$). Though not significant, Hispanic toddlers had higher HEI scores compared with non-Hispanic white, non-Hispanic black, and non-Hispanic other toddlers (64.1 (SD 9.6) vs. 60.1 (SD 11.6), $P=.305$; 61.3 (SD 11.6), $P=.485$; and 63.1 (SD 11.2), $P=.850$, respectively) (Table 1).

All HEI-2010 component scores were significantly lower than their respective maximum scores ($P<.001$) (higher scores reflect better diet quality for all components, as moderation components are reverse scored) (Table 2). Figure 1 is a radar graph to simultaneously show the percent of the maximum score achieved for each component; a perfect HEI-2010 total score (100% for each component) would be displayed as a line around the border of the radar graph. As demonstrated, the largest contributors to the HEI score were dairy, empty calories and total fruit, followed by total protein, refined grains and whole fruit. Toddlers consumed higher amounts of dairy and total fruit and lower amounts of empty calories and refined grains. However, toddlers consumed lower amounts of unsaturated fatty acids (i.e. fatty acid ratio), greens and beans and seafood and plant proteins and higher amounts of sodium. HEI-2010 component scores varied by race/ethnicity. In contrast to non-Hispanic white children, Hispanic and non-Hispanic black children had poorer whole fruit scores (4.3 (SD 1.4) vs. 3.8 (SD 1.9), $P=.037$ and 3.3 (SD 2.1), $P=.010$, respectively), and Hispanic children had better refined grain component scores (8.3 (SD 2.7) vs 6.4 (SD 2.9), $P=.005$). No other components varied by race/ethnicity.

No children achieved the maximum score of 100 for total HEI score (Table 2). Most toddlers (79%) consumed the recommended amount of dairy. Many (65%) consumed the recommended amount of total fruit and whole fruit (63%) and nearly half (53%) of protein foods. Less than a quarter of children consumed the recommended amount of seafood and plant proteins (18%) and greens and beans (16%) and very few for whole grains (13%), total vegetables (10%) and unsaturated fatty acids (7%). Over half (55%) of toddlers consumed more than recommended amount of refined grains and empty calories and 81% consumed too much sodium. In contrast to non-Hispanic white children, Hispanic children were more likely to consume the recommended amount of refined grains (54% vs. 38%, $P=.007$).

Discussion

A significant finding of the present study is that overall diet quality is poor, particularly among diverse, low-income toddlers and can vary by race/ethnicity. Although many toddlers were consuming adequate amounts of fruit, dairy and foods high in protein, diets were generally lacking in other foods important not only for the prevention of obesity and chronic disease, but also for optimal growth and development, such as seafood and plant proteins.^{28,29} Toddlers were falling short in their intake of vegetables, whole grains and greens and beans, while consuming too much sodium and saturated fatty acids. Among the few studies that have evaluated individual HEI-2010 dietary components among young children in the

U.S., results are similar in that scores were highest for dairy, fruit, and protein foods, while most had suboptimal scores for seafood and plant proteins and greens and beans.^{15,30–32} These studies, together with previous studies examining consumption patterns of young children,^{5,33} suggest diets of children need improvement early on.

Among the few studies that have examined diet quality using HEI-2010, most are among older groups of less diverse children and show that as children age HEI-2010 scores decrease.^{14,15,31,34} Comparatively, we found slightly higher HEI scores in our younger, more diverse sample. In addition to the young age of our sample, receiving WIC benefits could explain the higher scores. In our sample, 87% of families were receiving WIC benefits, and those who were not receiving WIC benefits were more likely to have higher income levels, perhaps protecting their diet quality. Studies show diet quality is often better among children receiving WIC compared to children of similar economic status not receiving WIC;^{35,36} especially since the WIC food package was updated in 2009 to include more fruits and vegetables and a switch to low fat milk.^{37–39} Young children from WIC participating households demonstrate better diet quality, driven largely by increases in greens and beans, whole grains and unsaturated fatty acids and decreases in 100% juice.^{30,38,40,41} Together, these results suggest receiving WIC benefits could explain the higher HEI scores observed among this population and the importance of this program on diet quality of low-income children.

Over half of our sample included caregivers born outside the U.S., mostly (59%) from Mexico. Children from these caregivers demonstrated higher HEI-2010 scores. Other studies have demonstrated children from immigrant families, particularly among those of Mexican descent, have better diet quality.^{14,42,43} However, more time spent in the U.S. often results in poorer diet,⁴⁴ which is likely due to adherence to the typical U.S. diet high in refined grains and added sugars compared to the more healthy foods found in traditional Mexican diets, including vegetables, legumes and whole grains.⁴⁵ In fact, Hispanic children in our sample had higher HEI scores and consumed less refined grains. These results highlight the importance of encouraging immigrant Hispanic families to maintain components of their traditional diet while trying to adjust to U.S. dietary patterns.

We found that toddlers from caregivers with obesity had lower HEI scores. Possible explanations include the shared food environment at home or role modeling of poor eating behaviors.⁴⁶ Additionally, toddlers from caregivers who were married or living with their partner had better diet quality. Studies show that diet quality differs among single vs. married mothers, marked by lower intakes of fruits and vegetables and higher intake of energy dense foods.^{47,48}

Our results for the fatty acid ratio and the greens and beans HEI component scores differed slightly compared to published literature. Mean component scores for the fatty acid ratio were lower compared to scores reported in other studies.^{15,30–32} One reason for this could be the high prevalence of milk consumption, typical of 2-year olds.^{6,49} Most (93%) were consuming milk, and of those 40% were consuming whole milk. Milk is a top contributor to both energy and saturated fat intake among young children.⁶ The mean component score for greens and beans was comparatively higher. As described earlier, studies show

legumes are commonly consumed among Latino populations and 57% of our population was Hispanic.^{50,51} This presents an opportunity to offer targeted interventions promoting the use of nuts and beans that are often found in traditional Hispanic and Latino dishes to increase diet quality.

Our study has several limitations. The use of a parent/caregiver proxy may have led to incomplete recalls, particularly if a child spends part of their day in a different environment. However, proxies are successfully used in many national surveys and are considered accurate to assess young children's diets.⁵² It is possible that caregivers, because of desirability bias, reported intakes that were more favorable than accurate. Nevertheless, study findings show very low intake of vegetables and whole grains and a lower than desirable HEI. Also, while the HEI has been updated beyond the 2010 version, we use the 2010 version because of the match with the standards at the time. The strengths of this study include the diverse racial and economic background of the sample and the developmental life stage that was targeted. Importantly, the age group targeted in this study is considered high risk for obesity in today's food environment.

Understanding diet quality at this young age is important since nutrition plays an essential role in growth, development, and health. Our findings can be used to influence nutrition education and policy aimed at improving diet quality and provide nutrition education to parents and caregivers, specifically around increasing intake of whole grains, vegetables and unsaturated fats. Healthcare providers can play an active role in helping parents and caregivers understand the importance of healthy eating from an early age. A unique aspect of the WIC program is the requirement to provide nutrition education, which, given our results, could play an influential role in improving diet quality; the program dedicates considerable resources to developing and conducting high-quality, participant-centered learning. Additionally, the American Academy of Pediatrics and the Centers for Disease Control and Prevention have resources for parents, caregivers, and providers that support adopting a healthy dietary pattern.⁵³ Our results may be useful to the U.S. Department of Agriculture and Department of Health and Human Services as they work to extend the *Dietary Guidelines for Americans* to children under the age of 2 years for the first time. The project, informally called the "B-24 project," aims to develop information and guidance on feeding and nutrition to achieve optimal growth and development for infants and toddlers.⁵⁴ The findings from this study provide evidence that diet quality could be improved by increasing intake of vegetables, especially dark-green vegetables and peas and beans; substituting whole-grain for refined-grain products and seafood for some meat and poultry; choosing more nutrient-dense forms of foods, that is, foods low in solid fats and free of added sugars. Such changes would potentially reduce the risk for obesity by encouraging consumption of foods associated with a healthy weight.

Conclusions

Overall, diet quality in this cohort of low-income, diverse 2-year olds was poor. This study informs future directions for research because it prompts us to think through modifiable factors of toddler diet such as caregiver modeling, home environment and the importance of nutrition support programs, such as WIC. It also highlights the need for culturally tailored

interventions. Thinking through methods to provide parental support for all race/ethnicities to support healthy eating may ultimately create improved toddler dietary intake which may have broad ranging clinical implications. Future research efforts could target interventions to test increasing consumption of fish, legumes, whole grains and unsaturated fatty acids and decreasing sodium intake to allow children to grow up with healthier dietary habits. Future research efforts should also examine racial and ethnic disparities in the relationship of toddler dietary patterns to later obesity.

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What is Known

- Early childhood nutrition is critical for optimal growth and development
- Patterns of dietary intakes during early childhood influence later healthy eating habits
- Racially and ethnically diverse children are at higher risk for obesity

What is New

- In a diverse, low-income cohort of toddlers, many are consuming low quality diets as measured by the Healthy Eating Index (HEI)
- Toddlers are consuming inadequate amounts of whole grains, vegetables and unsaturated fatty acids

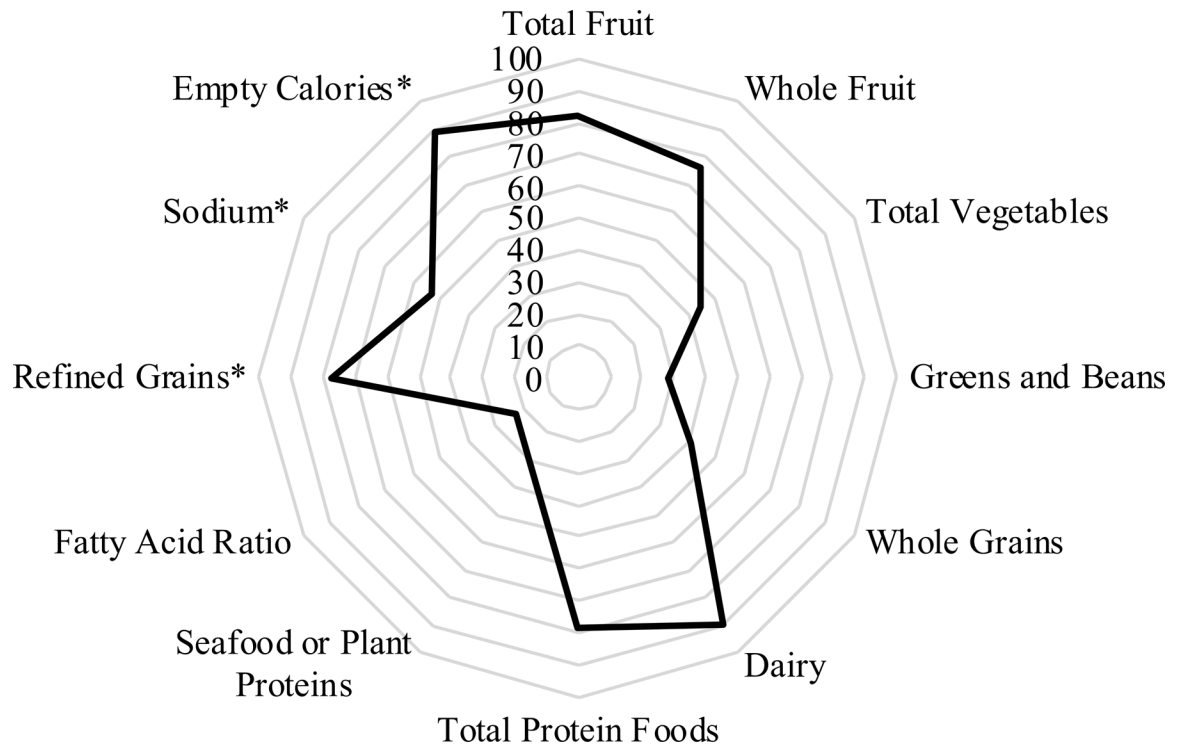


Figure 1. Radar plot showing the Healthy Eating Index (HEI)-2010 scores for toddlers participating in Greenlight (n=231). For each component, the plot is showing the percentage of total points received.

*Moderation components – higher score indicates lower consumption.

Table 1.

Sociodemographic characteristics for toddlers (24–34 months) with 24-hour dietary recall data and mean Healthy Eating Index (HEI)-2010 score, who participated in the Greenlight Study (n=231).

Characteristics		N (%)	HEI score, ¹ mean (sd)
Sex	Female	128 (55)	63.2 (10.9)
	Male	103 (45)	62.3 (10.1)
Race/ethnicity	Hispanic	131 (57)	64.1 (9.6)
	Non-Hispanic white	29 (13)	60.1 (11.6)
	Non-Hispanic black	63 (27)	61.3 (11.6)
	Non-Hispanic other	8 (3)	63.1 (11.2)
Household income ^{2,3}	<\$19,999	141 (64)	62.9 (10.3)
	\$20,000	81 (36)	62.8 (11.2)
Child BMI percentile ⁴	Underweight (<5 th percentile)	12 (6)	58.9 (11.0)
	Healthy weight (5 th to <85 th)	153 (73)	62.8 (10.7)
	Overweight (85 th to <95 th percentile)	30 (14)	64.7 (8.5)
	Obese (≥95 th percentile)	15 (7)	62.2 (11.9)
Received WIC benefits ^{2,5}	Yes	200 (87)	62.8 (10.5)
	No	30 (13)	63.4 (10.4)
Food insecure ^{2,5}	Yes	117 (51)	62.8 (10.9)
	No	113 (49)	62.7 (10.1)
<i>Caregiver characteristics</i>			
Education ⁵	Less than high school	68 (30)	61.7 (11.3)
	High school graduate	68 (30)	63.2 (9.2)
	Some college	54 (23)	62.5 (10.9)
	College graduate	40 (17)	64.2 (10.9)
Age	<30 years	123 (53)	61.1 (10.7) [*]
	30–34 years	66 (29)	64.0 (9.36)
	≥35 years	42 (18)	66.1 (11.1) [*]
Obesity (BMI ≥30.0) ^{2,6}	Yes	72 (35)	60.0 (10.2) [*]
	No	131 (65)	64.6 (10.6)
Born in the U.S.	Yes	101 (44)	60.1 (10.3) [*]
	No	130 (56)	64.9 (10.3)
Married ^{2,4}	Yes	142 (68)	64.2 (10.0) [*]
	No	68 (32)	59.8 (10.8)

¹ Healthy Eating Index, maximum score is 100

² Measured at baseline at the 2-month well-child visit

³ Missing 9

⁴Missing 21

⁵Missing 1

⁶Missing 28

*
p<.05

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Table 2.

Mean and standard deviation for Healthy Eating Index-2010 component and total scores with median and interquartile range for toddlers participating in Greenlight (24–34 months) (n=231).

Dietary Component ¹ (Max Score)	Mean	SD	Median	IQR	Percent of toddlers who achieved max score
<i>Adequacy (higher scores indicate higher consumption)</i>					
Total Fruit (5)	4.1	1.5	5.0	3.4–5.0	65
Whole Fruit (5)	3.8	1.9	5.0	2.8–5.0	63
Total Vegetables (5)	2.2	1.4	1.9	1.1–3.1	10
Greens and Beans (5)	1.4	1.9	0.0	0.0–3.0	16
Whole Grains (10)	4.1	3.5	3.7	0.7–7.1	13
Dairy (10)	9.0	2.4	10.0	10.0–10.0	79
Total Protein Foods (5)	3.9	1.5	4.8	2.9–5.0	53
Seafood and Plant Proteins (5)	1.5	2.0	0.0	0.0–3.0	18
Fatty Acid Ratio (10)	2.3	3.1	0.9	0.0–3.5	7
<i>Moderation (higher scores indicates lower consumption)</i>					
Refined Grains (10)	7.7	2.9	9.0	5.9–10.0	45
Sodium (10)	5.3	3.4	5.4	2.4–8.5	19
Empty Calories (20)	17.8	3.1	19.1	16.2–20.0	45
Total HEI-2010 Score (100)	62.8	10.5	64.0	55.4–70.4	0

¹ A higher number signifies a healthier amount of intake