

Nutrient Contribution of the Dinner Meal Consumed by Low-Income Minority Preschool Children

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Abstract: *Objective:* To examine the energy and nutrient intake of dinner of low income preschool minority groups, African-Americans and Mexican-Americans, attending Head Start (HS).

Design: Cross-sectional study of intake at dinner using digital photography was undertaken. Pictorial records were converted to energy and nutrient intakes using NDS-R Nutritional software. Means±SE for total grams of food and beverages, energy, and macro- and micro-nutrients were determined and compared with recommendations.

Setting: Home assessment dinner of children enrolled in HS in Houston, TX.

Subjects: Low-income children (n=214), 3 to 5 years (mean age 4.4 ± 0.7 years; 48% boys; 53% Mexican-American).

Results: Energy from food and beverages and food was 350.29±10.36 kcals and 302.35±10.46 kcals, respectively. Mean protein, carbohydrate, and total fat intakes were 14.22±0.52 g (16.32% of total energy), 44.33±1.25 g (52.24%), and 13.18±0.56 g (32.29%), respectively, which provided 95.4±0.52%, 44.5±1.25%, and 10.4±0.11% of the requirements for protein, carbohydrate, and dietary fiber, respectively; these were consistent with recommendations. Intakes of vitamin D, calcium, and potassium were 0.66±0.08 mcg, 102.61±5.03 mg, and 404.42±13.63 mg, respectively; which constituted only 6.6±0.08%, 12.7±5.03%, and 10.7±13.63% of these nutrients of public health concern.

Conclusions: Children participating in HS had low intakes of nutrients of public health concern at the dinner meal. The dinner meal is an integral part of the daily intake of preschool children and this study suggests that micronutrient intakes could be improved. It is important to educate mothers and children as to what constitutes a nutrient-dense meal and to confront barriers to consumption of these meals.

Keywords: Preschool children, diet, nutrients, Head Start, dinner meal.

INTRODUCTION

Healthful eating patterns in children, including consuming the recommended intakes of energy [1], macro-[1] and micro-nutrients [2-4], may be associated with positive health outcomes, including lower risk for obesity, and acute and chronic diseases. Data from the 2009-2010 National Health and Nutrition Examination Survey (NHANES) showed that nearly 27% of US children 2 to 5 years of age (y) were overweight or obese [5]. There was also considerable variation in race/ethnicity, with Hispanic children having a higher prevalence of overweight/obesity than either black or white preschool children [5]. Low-income children, attending Head Start (HS), a school readiness program, may be more likely to be overweight or obese than other pre-school children [6-8].

Although the causes of obesity are complex, high energy intake likely contributes to childhood obesity, especially when combined with low levels of physical activity [9-10]. Children's intake of total energy has also

has also increased over time [9]. Obesity in children increases the risk of diseases previously seen mostly in adults, including hyperlipidemia [11], hypertension [11], metabolic syndrome [12], and type 2 diabetes [12]. Overweight children also suffer from diminished health-related quality of life [13], bullying/teasing [14], and low self-esteem [15].

Inadequate consumption of foods rich in dietary fiber, vitamin D, calcium, and potassium are major public health concerns [16]. In children and adolescents, dietary fiber intake is inversely associated with serum cholesterol levels [17] and constipation [18], a major cause of morbidity in children [19]. Inadequate intake of nutrients, such as calcium and vitamin D [20], in combination with a sedentary lifestyle in childhood [20, 21], can impede the achievement of maximal bone mineral content and density, thereby increasing the diet-related risk of developing osteoporosis later in life. Excess consumption of saturated fatty acids (SFA) has been associated with increased plasma total and low-density lipoprotein cholesterol in childhood [22-24], which could increase cardiovascular disease risk; however, recent research has brought this association into question [25, 26]. High levels of sodium intake

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have been associated with higher levels of blood pressure in children [27].

Preschool children, especially, low-income children, are at high risk for under- or over-nutrition, placing them at nutritional risk [28]. Preschool children attending HS may be at higher risk of not meeting the Recommended Dietary Allowance for several key nutrients than other low-income children [28]. However, little is known of the diet of preschool children, especially the dinner meal. The most recent report from What We Eat in American (WWEIA) [29], using data from the 2007-2008 NHANES, showed that overall in males and females 2-5 y, proxies reported that 96% and 95%, respectively, consumed a dinner meal. Figures were slightly lower in children living in homes less than 131% of the federal poverty level; 94% of those children were reported to consume dinner, as compared with 98% of children living in homes above 185% of the poverty level. The prevalence of consuming a dinner meal in these children varied widely by race with the lowest prevalence (85%) seen in Mexican-Americans, followed by black (96%) and white children (99%). This pattern was also observed for nutrient intake, which, in general for Mexican-Americans (MA) was lower than in either black or white children. WWEIA does not look at ethnicity and income together and does not look specifically at children attending HS. The goal of this study was to examine the energy and nutrient intake of the dinner meal, in two low income minority groups, African-Americans (AA) and MA, of preschool aged children attending HS.

EXPERIMENTAL METHODS

Participants

Parents were recruited from HS centers in Houston, Texas. The purpose of the study was explained to them and they were asked if they would participate in a study which involved two home observations of their child's dinner meals. Consent forms were signed by the parent at the beginning of the first home observation. During the two home observations, pre-school children were observed during dinner by staff members. At the end of each observation, parent-report questionnaires (available in English or Spanish) were given to the parent to complete; these were collected at the next observation. Demographic information was collected through these questionnaires. Parents received an incentive at the end of each of the two observations. This study was conducted according to the guidelines

laid down in the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the Institutional Review Board at Baylor College of Medicine. Written informed consent was obtained from all subjects/patients.

Food Intake

Dinner meals of the targeted HS child were studied for two days. A standardized digital photography method was used to measure the amount of food placed on the dinner plates [30-32]. Standard plates, bowls, and cups were provided to the families in order to standardize photographs. Foods were photographed using digital cameras (Sony Digital Handy Cam DCR-VX1000; Sony Corporation of America, New York, NY). Staff members were took photographs of the plates at 2' above and 2' away from the center of the plate at an angle of $\sim 45^\circ$. If the child was served or consumed second or third servings, these were estimated relative to the original portion size. Second or third servings were estimated as one-fourth, one-half, three-fourths or the same as the original portion size. Trained staff measured any plate waste unobtrusively in the kitchen, *i.e.* away from the family. Individual foods were separated and weighed one at a time on a food scale. Gram amounts were documented on a plate waste form.

Detailed information on menus, recipes and preparation method was collected from the mother prior to each eating occasion. Additionally, descriptive information such as brand names and form of ingredients (e.g., fresh, frozen, or canned) were collected, as well as food labels when appropriate. The documented recipes were recreated by trained staff in the kitchen at the Children's Nutrition Research Center (CNRC). Usually the recipe was followed as described by the participant with exact ingredients and preparation methods. On occasion, an ingredient may have been unattainable and a similar food was substituted. For each food recreated in the CNRC kitchen, reference pictures were taken in 10 gram increments using the digital photography method (Figure 1). Foods were photographed one at a time and at four positions on the plate. Trained staff used these multiple reference pictures to estimate the gram amounts of food documented in the digital photos taken in the homes.

A computer application was used to simultaneously display the digital photographs of the reference portions and meal plate showing food selection,

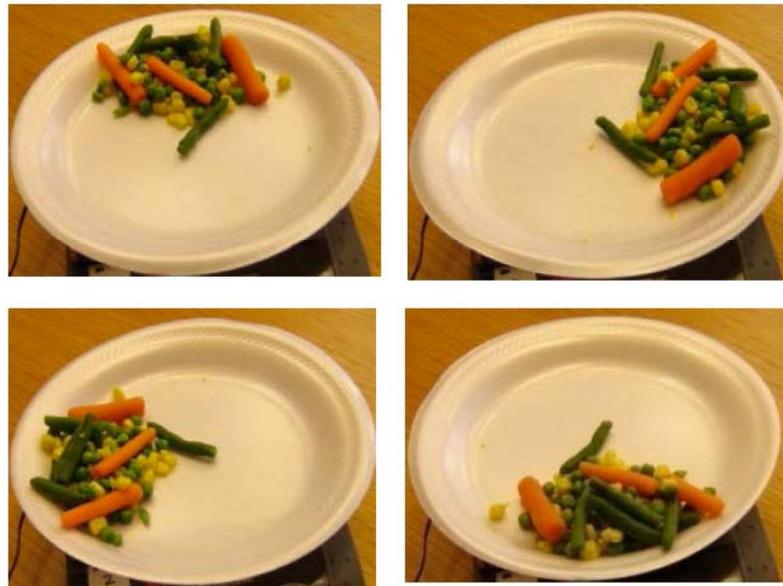


Figure 1: Reference picture library example: steamed broccoli orientation (top) and plate orientation photos (bottom).

seconds (or thirds), or plate waste. Trained research staff estimated the percent of the reference portion of the food selections, and these estimates were entered into a computer application [33,34]. This digital photography method has been found to be reliable and accurate when used to measure the food intake of preschool children [33, 34]. A detailed estimation of portion sizes is shown in Figure 2.

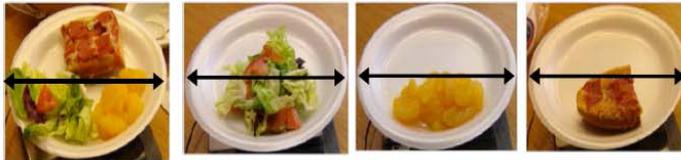
To determine the energy and nutrient content for foods served on the dinner plates, foods were coded using the Nutrition Data System-Research (NDSR) (NDS version 2006, Nutrition Coordinating Center, University of MN). For each food item, the nutrient content was expressed per gram and was multiplied by the gram weight for portion size, plate waste, and food intake for each child. Results for macronutrients in



Step 1: Open field plate picture



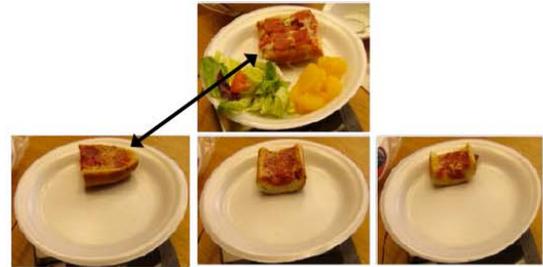
Step 2: Open reference pictures



Step 3: Resize meal plate and reference pictures for equidistant diameters



Step 4: Find the reference pictures in which the food item is in the same orientation as in the field plate



Step 5: Identify the closest reference picture portion to the field plate portion



Step 6: Compare the field plate portion to all orientations of the identified portion in step 5 and decide whether the identified size is actually the closest to the field portion

Step 7: If the size is the closest to the field portion, enter the identified size in the "estimates form"; if not, repeat steps 4 through 6

Figure 2: A step-by step method for the estimation procedure.

each food selection were downloaded and merged with other variables in the master database. The actual amount of a given food consumed by the participant was determined by subtracting the amount of plate waste from non-edible refuse from the starting amounts of various foods.

Body Mass Index (BMI) and Weight Status

Height and weight measurements were obtained by trained staff members following standardized procedures [35]. Height and weight were measured in duplicate to assure accuracy. Height and weight scores for children were converted to age- and gender-specific BMI z-scores using the revised 2000 growth charts from the Centers for Disease Control and Prevention [36].

Statistical Analyses

All statistical analyses were conducted using the Statistical Analysis Software (SAS) (version 9.2, SAS Institute Inc Cary, NC, 2008). Means and standard

errors for total grams of food and beverages consumed, total energy, energy density, and macronutrients and micronutrients were determined. Energy density was defined as mean total energy (in kilocalories [kcal]) consumed/mean total gram amount [37] consumed. Means energy intake and macronutrients were compared with the estimated energy requirements [1] and acceptable macronutrient distribution range [1]. Intakes of macronutrients and micronutrients were compared with the estimated average requirement, recommended dietary allowances, or adequate intakes, as appropriate [2-4] and a percentage was calculated.

RESULTS

Demographics of the Sample (Table 1)

The study initially included 231 preschool children attending HS. Seventeen children were excluded in the analyses because they were missing demographic data, resulting in a final sample size of 214. Children participating in the study ranged from 3 to 5 y with a

mean age of 4.4 ± 0.7 years (48% boys; 53% MA). Approximately 14% of the children were overweight and 25% were obese.

Table 1: Demographic Characteristics of the Sample of Preschool Children (n=214)

Ethnicity, n (%)	
Mexican-American	114 (53.27)
African-American	100 (46.73)
Child age years, mean \pm SD	4.43 \pm 0.68
Age (years), n (%)	
≤ 4	64 (29.91)
$>4 \leq 5$	107 (50.00)
> 5	43 (20.09)
Gender, n (%)	
Male	103 (48.13)
Female	111 (51.87)
BMI, mean \pm SD	16.78 \pm 2.24
BMI, z-score mean \pm SD	0.71 \pm 1.22
BMI category, n (%)	
Normal weight (< 85th percentile)	131 (61.21)
Overweight (\geq 85th and < 95th percentile)	29 (13.55)
Obese (\geq 95th percentile)	54 (25.23)

Abbreviations: SD = standard error, BMI = body mass index.

Gram Amount of Food and Beverages, Energy, Energy Density, and Energy Sources (Table 2)

Overall the total amount of food and beverages served was 325.76 ± 6.71 g, of which 187.49 ± 5.67 g was food. Energy from food and beverages and food only was 350.29 ± 10.36 kcals and 302.35 ± 10.46 kcals, respectively. Energy density from food and beverages and food only was 1.09 ± 0.03 and 2.01 ± 0.05 , respectively. Protein, carbohydrate, and total fat was 14.22 ± 0.52 g (16.32% of total energy consumed), 44.33 ± 1.25 g (52.24%), and 13.18 ± 0.56 g (32.29%), respectively. Mean added sugars and dietary fiber intake was 11.91 ± 0.63 g and 2.58 ± 0.11 g, respectively. Total saturated fatty acid (SFA) and cholesterol intake was 4.24 ± 0.2 g (10.43%) and 43.21 ± 2.5 mg, respectively.

Contribution of the Dinner Meal Compared with Estimated Energy Requirements and the Acceptable Macronutrient Distribution Ranges (Table 3)

Overall, energy intake (kcals) from the dinner meal was $21.97 \pm 2.13\%$. When compared with estimated

energy requirements for children who were sedentary, low active, active, and very active, $28.16 \pm 0.84\%$, $24.44 \pm 0.73\%$, $21.67 \pm 0.65\%$, and $18.62 \pm 0.56\%$ of the energy was consumed at the dinner meal, respectively. When compared with the acceptable macronutrient distribution range for protein, carbohydrates, total fat, and SFA, children consumed $16.34 \pm 0.33\%$, $52.24 \pm 0.78\%$, $32.29 \pm 0.64\%$, and $10.44 \pm 0.27\%$, respectively. The dinner meal consumed provided $95.4 \pm 0.52\%$, $44.5 \pm 1.25\%$, $10.4 \pm 0.11\%$, and $35.8 \pm 0.02\%$ of the requirement for protein, carbohydrate, dietary fiber, and omega-3 fatty acids, respectively.

Micronutrient Content of Dinner Meals Consumed by Preschool Children (Table 4)

Vitamin A, D, E, and K intake was 83.78 ± 5.61 mcg, 0.66 ± 0.08 mcg, 1.1 ± 0.05 TAC mg, and 14.99 ± 1.25 mcg, respectively. The coefficient of variation of the intake amounts varied considerably for these fat soluble vitamins: 102%, 181%, 66%, and 127%, respectively. Total folate intake was 67.11 ± 2.9 mcg and vitamin C intake was 20.6 ± 1.64 mg. Intake of calcium, phosphorus, magnesium, sodium, and potassium was 102.61 ± 5.03 mg, 193.46 ± 6.78 mg, 40.62 ± 1.35 mg, 664.71 ± 23.81 mg, and 404.42 ± 13.63 mg, respectively. Intake of other micronutrients is presented in Table 4.

The dinner meal consumed also provided $43.4 \pm 9.21\%$, $6.6 \pm 0.08\%$, $18.4 \pm 0.05\%$, and $26.7 \pm 1.25\%$ to total intake of vitamin A, D, E, and K, respectively. The dinner meal provided $42.1 \pm 2.90\%$ and $94.6 \pm 1.65\%$ to total intake of total folate and vitamin C, respectively. The dinner meal also provided $12.7 \pm 5.03\%$, $47.7 \pm 6.78\%$, $37.5 \pm 1.35\%$, $55.8 \pm 23.81\%$, and $10.7 \pm 13.63\%$ to total intake of calcium, phosphorus, magnesium, sodium, and potassium, respectively. The comparison of other micronutrients with requirements is found in Table 4.

DISCUSSION

This study showed that 38.78% of HS children were overweight or obese. This study also showed that HS children consumed macronutrient percentages within recommendations, but that percent intake of some micronutrients, including those of public health concern, dietary fiber, vitamin D, calcium, and potassium [16], was low. Although the 2010 DGA identified calcium as a nutrient of concern in individuals 9 y and older, it may be of concern in this population,

Table 2: Characterizing Dinner Meals Consumed by Preschool Children in Head Start by the Gram Amount, Energy, Energy Density, And Energy Sources

Energy/Nutrient	Mean±SE	Min-Max	CV%
Total Grams Food & Beverage	325.76±6.71	86.33-638.71	31.3
Food Grams	187.49±5.67	33.61-480.6	46.0
Energy (kcal) from Food & Bev	350.29±10.36	53.08-986.49	44.9
Energy from Foods (kcal)	302.35±10.46	45.89-964.62	52.6
Energy Density from Food & Bev	1.09±0.03	0.17-2.38	35.3
Energy Density from Food only	2.01±0.05	0.56-4.57	35.0
Energy Sources Total Protein (g)	14.22±0.52	2.06-53.71	55.3
% calories from protein	16.34±0.33	6.11-33.88	30.1
Animal Protein (g)	9.91±0.44	0.62-44.52	67.9
Vegetable Protein (g)	4.31±0.16	0.44-14.98	56.7
Total Carbohydrate (g)	44.33±1.25	3.93-132.63	42.9
% calories from carbohydrate	52.24±0.78	16.54-81.20	70.0
Total Sugars (g)	18.28±0.68	0.35-52.54	56.7
Added Sugars (g)	11.91±0.63	0-49.78	80.9
Fructose (g)	5.05±0.23	0.01-18.73	69.2
Sucrose (g)	6.9±0.37	0.03-32.62	82.4
Starch (g)	20.77±0.84	0.91-71.56	61.3
Total Dietary Fiber (g)	2.58±0.11	0.17-10.94	64.9
Total Fat (g)	13.18±0.56	0.98-63.6	64.1
% calories from total fat	32.29±0.64	10.84-68.25	88.1
Total SFA (g)	4.24±0.2	0.31-24.6	30.8
% calories from SFA	10.43±0.27	2.69-26.39	39.3
Total MUFA (g)	4.95±0.22	0.38-28.77	68.6
% calories from MUFA	12.10±0.28	2.66-30.87	35.5
Total PUFA (g)	2.8±0.16	0.12-18.83	87.9
% calories from PUFA	6.77±0.25	0.97-24.52	57.2
Total Trans-Fatty Acids (g)	0.79±0.05	0.02-4.56	100.4
Omega-3 Fatty Acids (g)	0.32±0.02	0.02-2.53	103.9
Cholesterol (mg)	43.21±2.5	2.35-274.34	22.6
Water (g)	259.52±5.82	76.37-560.3	34.1

Abbreviations: SE = standard error; CV = coefficient of variation; kcal = kilocalorie; g = gram; SFA = saturated fatty acids; MUFA = monounsaturated fatty acids; PUFA = polyunsaturated fatty acids; mg = milligrams.

Table 3: The Contribution of the Dinner Meal Consumed by Preschool Children to the Recommended Intake of Energy and Macronutrients

	Ref: day1		% from Dinner meal	
	1-3yrs	4-8yrs	Mean %±SE	Min-Max
Energy (kcal)	M=1230 ² F=1165	M=1715 F=1548	21.97±2.13	7.83-52.34
Energy Estimated: Sedentary	Estimated Energy Requirement (EER)		28.16±0.84	3.95-80.80
Energy Estimated: Low Activity			24.44±0.73	3.44-69.61
Energy Estimated: Activity			21.67±0.65	3.05-61.61
Energy Estimated: Very Activity			18.62±0.56	2.68-51.70
	1-3yrs	4-8yrs		
	AMDR (% of total energy)			
Total Protein (g) % of Energy	5-20%	10-30%	16.34±0.33	6.11-33.88
Total CHO (g) % of Energy	45-65%	45-65%	52.24±0.78	16.54-81.20
Total Fat (g) % of Energy	30-40%	25-35%	32.29±0.64	10.84-68.25
SFA (g) % of Energy	<10%	<10%	10.44±0.27	2.69-26.39
MUFA (g) % of Energy	N/A		12.10±0.28	2.66-30.87
PUFA (g) % of Energy	N/A		6.77±0.26	0.97-24.52
Trans-Fats (g) % of Energy	< 1 %	< 1 %	1.95±0.11	0.11-11.20
	Ref: per day		% from dinner meal	
	1-3 yrs	4-8 yrs	Mean %±SE	Min—Max
Macronutrients/Fiber				
Total Protein (g)	11 ¹	15 ¹	95.4±0.52	13.7-358.1
Total Carbohydrate (g)	100 ¹	100 ¹	44.5±1.25	3.9-132.6
Total Dietary Fiber (g)	19 ²	25 ²	10.4±0.11	0.7-43.8
Omega-3 Fatty Acids (g)	0.7 ²	0.9 ²	35.8±0.02	1.7-280.6

¹Estimated Energy Requirements (EERs), Acceptable Macronutrient Distribution Range (AMDR, % total energy intake).

²These figures assume an average level of physical activity; people with a high level of activity have higher requirements, and those with a very sedentary life-style have lower requirements.

Abbreviations: SE = standard error; AMDR = Acceptable Macronutrient Distribution Range; g = gram; SFA = saturated fatty acids; MUFA = monounsaturated fatty acids; N/A = not available; PUFA = polyunsaturated fatty acids.

since the dinner meal supplied only 12.7% of the daily recommendation.

This study showed a higher prevalence of overweight/obesity than has been shown in a nationally representative sample of children 2-5 y [5]; other studies [6, 7] have also shown that children participating in HS have a higher prevalence of overweight/obesity than the national average. Although causes of overweight/obesity are multifactorial, clearly diet plays an important role. Thus, understanding diet in this population is critical.

Children's eating patterns are initiated early in life (*i.e.*, 2 to 5 y) suggesting that the preschool period is a pivotal developmental time point during which healthful eating patterns may be fostered [38-42]. Nutrient intake

of preschool children has been understudied, and very little is known about the nutrient intake at the dinner meal among this population, in general, and about HS children in particular. Head Start Centers must provide children in part-day programs $\frac{1}{3}$ of the child's daily nutritional needs; whereas those programs providing full-day programs must provide $\frac{1}{2}$ to $\frac{2}{3}$ of the nutritional needs—depending on the length of the program day [43]. One previous study showed, however, that half-day HS children consumed up to 25% of the daily recommendation for energy and nutrients, whereas all-day HS children consumed only a third of the recommendations [44]. Further, Bucholz, *et al.* [28], using 1999-2004 NHANES data showed that HS children were at a higher risk than other low income preschool children for not meeting dietary recommendations.

Table 4: Characterizing Dinner Meals Consumed by Preschool Children Attending Head Start by the Micronutrient Content

Energy/Nutrient	Mean±SE	CV%	Ref: per day		Mean %±SE from dinner Meal
			1-3 yrs	4-8 yrs	
Vitamins					
Vitamin A (mcg)	83.78±5.61	101.7	210 ¹	275 ¹	43.4±9.21
Vitamin D (mcg)	0.66±0.08	181.3	10 ¹	10 ¹	6.6±0.08
Vitamin E (TAC mg)	1.1±0.05	66.1	5 ¹	6 ¹	18.4±0.05
Vitamin K (mcg)	14.99±1.25	126.5	30 ¹	55 ¹	26.7±1.25
Thiamin (mg)	0.28±0.01	56.9	0.4 ¹	0.5 ¹	55.6±0.01
Riboflavin (mg)	0.28±0.02	87.7	0.4 ¹	0.5 ¹	56.8±0.02
Niacin (mg)	3.97±0.17	65.3	5 ¹	6 ¹	66.5±0.17
Pantothenic acid (mg)	0.72±0.03	54.9	2 ³	3 ³	24.1±0.03
Vitamin B-6 (mg)	0.29±0.01	56.7	0.4 ¹	0.5 ¹	58.8±0.01
Total Folate (mcg)	67.11±2.9	65.6	120 ¹	160 ¹	42.1±2.90
Vitamin B-12 (mcg)	0.66±0.04	86.0	0.7 ¹	1 ¹	66.2±0.04
Vitamin C (mg)	20.6±1.64	121.3	13 ¹	22 ¹	94.6±1.65
Minerals					
Calcium (mg)	102.61±5.03	74.5	500 ³	800 ³	12.7±5.03
Phosphorus (mg)	193.46±6.78	53.3	380 ¹	405 ¹	47.7±6.78
Magnesium (mg)	40.62±1.35	50.5	65 ¹	110 ¹	37.5±1.35
Iron (mg)	2.31±0.09	57.4	3 ¹	4.1 ¹	56.7±0.09
Zinc (mg)	1.77±0.07	56.6	2.5 ¹	4 ¹	44.8±0.07
Copper (mg)	0.2±0.01	57.1	260 ¹	340 ¹	0.1±0.01
Manganese (mg)	0.48±0.02	65.6	1.2 ³	1.5 ³	32.0±0.02
Selenium (mcg)	21.38±0.8	56.9	17 ¹	23 ¹	93.7±0.80
Sodium (mg)	664.71±23.81	54.4	1000 ³	1200 ³	55.8±23.81
Potassium (mg)	404.42±13.63	51.2	3000 ³	3800 ³	10.7±13.63

Abbreviations: SE = standard error; CV = coefficient of variation; g = gram; SFA = saturated fatty acids; mg = milligrams; mcg = micrograms.
¹Estimated Average Requirements (EARs); ²Recommended Dietary Allowances (RDAs); ³Adequate Intakes (AIs).

The findings that HS children may be at high nutrient risk underscores the importance of that the dinner meal, consumed away from the HS Center, plays an important role in helping children meet nutritional requirements. The dinner meal also provides an opportunity for parents to provide healthful foods [45] and to model consumption of healthful foods and eating behaviors [46] which can provide children with the basis for a lifetime of healthy eating [47, 48].

Previous studies, using 24-hour dietary recalls, have shown that children consumed between 26-31% of energy at the dinner meal [29, 49]. Twenty-four hour dietary recalls have inherent limitations, especially in young children since parents or guardians must serve as proxy reporters for young children [50, 51] which

could result in reporting errors [52]. Our study showed a lower percent energy from the dinner meal than previously reports [29, 49]. Depending on the physical activity levels of the child, the dinner meal provided approximately 19% to 28% of the daily estimated energy requirement. This study used a more accurate method of dietary assessment than 24 hour dietary recalls [32].

Until recently, it's not been clear if energy density of foods/beverages consumed was associated with overweight in children [53]; however, a recent systematic review has shown that that consumption of high energy density of foods/beverages has been associated with overweight in children [54]. A previous study also shown that children from lower income

homes, such as those participating in HS, tend to consume higher energy density foods than those from lower income homes [53]. Thus, it is important to educate low income mothers and children about the importance of serving nutrient dense foods.

The macronutrient distribution of energy from the dinner meals was well within the recommendations [1-4] for children 3-5 y; however, the percent of energy from SFA was slightly higher (10.8%) than recommended [1]. This high percentage intake could easily be balanced by consuming foods low in SFA during the remainder of the day. Mean dietary fiber intake was quite low, providing only 13.6% and 10.3% of the recommendations for children 1-3 y and 4-8 y [1], respectively. This suggests that children's total daily intake of dietary fiber is low; a finding that has been shown consistently [55, 56]. In children, as stated previously, fiber intake is inversely associated with serum cholesterol levels [17] and constipation [18], which is a major cause of morbidity in children [19]. Caregivers need to provide high fiber foods, including whole grains, fruit, and vegetables, and encourage their intake, at the dinner and other meals; they also need to model consumption of high fiber foods.

Consumption of most micronutrients at the dinner meal exceeded one third of daily recommendations [1-4]. However, of particular import were the low intakes of vitamin D, calcium, and potassium, all of which have been identified as nutrients of public health concern by the 2010 DGA [16]. A single 8 oz glass of non-fat milk, served and consumed at the dinner meal, would have provided 60% (children 1-3 y) and 37% (children 4-8 y) of the recommendation for calcium, 29% of the recommendation for vitamin D, and 12.7% (children 1-3 y) and 10.1% (children 4-8 y) of the recommendation for potassium [2, 57, 58]. Adequate intake of calcium, vitamin D, protein, and other key nutrients, early in life is crucial for achieving peak bone mass and reducing loss later in life [59, 60]. Encouraging consumption of low-fat dairy products at the dinner meal, as well as at other eating episodes, can help children increase their intake of these important nutrients. It is important that parents and other caregivers understand that the recommendations for children 2-3 y and 4-8 y are 2 and 2.5 cup equivalents, respectively [61].

Limitations

This was a convenience sample of HS preschool children which may not be representative of the HS population in Houston or other geographic locations.

Further, two days of observational data of a single meal may not represent usual intake. However, it is acceptable [62] to assess two meals to characterize intakes of a population; this has been the approach used in the NHANES surveys [63]. Conducting digital photography in the home may be viewed as intrusive with the potential of influencing the typical consumption of dinner meals and the family environment surrounding the dinner meals. However, the large amount of variation in the amount of food served and plate waste suggests that the children's eating behavior was not altered.

CONCLUSIONS

This study showed that children participating in HS had a high prevalence of overweight/obesity and had low intakes of nutrients of public health concern (dietary fiber, vitamin D, calcium, and potassium). The dinner meal could be an important component in helping children obtain these and other important nutrients. Nutrition educators should address healthy eating and consumption of recommended levels of high fiber foods, including whole grains, fruit, and vegetables, and low fat dairy with parents of preschool children. Additionally, nutrition education could be provided in HS centers to children and their parents. Education needs to be targeted specifically to racially/ethnically diverse groups. This may be an important strategy in the prevention and reduction of childhood obesity and a way to increase overall diet quality. Nutrition education is critical so that all individuals, regardless of ethnicity/race and income, understand the importance of consuming nutrient-dense foods. Moreover, these foods need to be made accessible and available to all low-income individuals.

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This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the Institutional Review Board at Baylor College of Medicine. Written informed consent was obtained from all subjects/patients.

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