Portion size effects on daily energy intake in low-income Hispanic and African American children and their mothers[1–3]

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ABSTRACT

Background: Portion size influences children's energy intakes at meals, but effects on daily intake are unknown.

Objective: Effects of large portions on daily energy intake were tested in 5-y-old Hispanic and African American children from low-income families. Maternal food intake data were collected to evaluate familial susceptibility to portion size.

Design: A within-subjects experimental design with reference and large portion sizes was used in a study of 59 low-income Hispanic and African American preschool-aged children and their mothers. The portion size of 3 entrées (lunch, dinner, and breakfast) and an afternoon snack served during a 24-h period were of a reference size in one condition and doubled in the other condition. Portion sizes of other foods and beverages did not vary across conditions. Weighed food intake, anthropometric measures, and self-reported data were obtained.

Results: Doubling the portion size of several entrées and a snack served during a 24-h period increased energy intake from those foods by 23% (180 kcal) among children ($P < 0.0001$) and by 21% (270 kcal) among mothers ($P < 0.0001$). Child and maternal energy intakes from other foods for which portion size was not altered did not differ across conditions. Consequently, total energy intakes in the large-portion condition were 12% ($P < 0.001$) and 6% ($P < 0.01$) higher in children and mothers, respectively, than in the reference condition. Child and maternal intakes of the portion-manipulated foods were not correlated.

Conclusions: Large portions may contribute to obesigenic dietary environments by promoting excess daily intakes among Hispanic and African American children. *Am J Clin Nutr* 2007;86:1709–16.

KEY WORDS Portion size, energy intake, eating behavior, obesity

INTRODUCTION

Marked increases in pediatric overweight since the mid-1970s (1, 2) highlight the role of the environment and its effects on behavior (3, 4). Exposure to large portions of energy-dense food may cause excessive energy intakes among children, but empirical evidence is limited (5–8). Nationally representative surveys have documented increases in average food portion sizes consumed by children in and outside the home since the late 1970s (9). Higher energy intakes among children are associated with larger average food portions consumed per eating occasion and larger meal sizes (10, 11). The cross-sectional nature of these survey data, however, precludes causal inferences about the effect of portion size on energy consumption.

Experimental research has shown that an increase in the entrée serving size at a meal produces elevations in preschool-aged children's total energy intakes at single meals (12–14). The extent to which large portions promote positive energy balance is contingent on the degree to which increases in meal energy intake are maintained over longer periods. Recent studies of adults have reported sustained portion size effects on energy intake over 2-d (15) and 11-d (16) periods, when all food and beverage portions were increased. Whether portion size has similar effects on daily energy intake among children is unclear because children demonstrate an ability to self-regulate energy intake within (17, 18) and across (19) meals.

This study tested portion size effects on food and energy intakes over a 24-h period among low-income 5-y-old Hispanic and African American children—populations known to be disproportionately affected by overweight (2). Portion size effects on maternal intake were also determined to evaluate familial resemblances in the tendency to overconsume large portions. Large portions were hypothesized to promote total energy intake over a 24-h period among children and mothers in both ethnic groups.

SUBJECTS AND METHODS

Design

The effects of portion size on total energy intake during a 24-h period were tested by using a within-subject design. Each child and mother participated in two 24-h conditions involving a single menu that differed only in the portion sizes of entrées served at 3 separate meals and an afternoon snack. Reference portions of

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these foods were served in one condition and were doubled in the other condition. The portion sizes of all other foods offered during the 24-h period were held constant across conditions. This aspect of the design was used to determine whether increasing the portion size of the entrées and snack influenced the intake of other foods for which portion size was not manipulated.

The order of condition presentation was randomly assigned to each mother-child pair, and the conditions were separated by ≥2 wk. Three to 4 families were seen on a given day, and all families participated in the same condition. Weighed food intake data were collected. Other measures included in this report were maternal and child body mass index (BMI), family demographics, and food insecurity.

Subjects

Participants were 28 African American and 31 Hispanic 5-y-olds ($n = 35$ girls, 24 boys) attending Head Start Programs in the greater metropolitan area of Houston, TX. Head Start is a national program that promotes school readiness through programs serving young children from primarily low-income families (Internet: http://www.acf.hhs.gov/programs/hsb/). Children and their mothers were identified by using flyers and on-site recruiting at Head Start Centers. This investigation focused on 5-y-olds because previous laboratory studies have consistently shown portion size effects on energy consumed at meals among children of this age (12–14). Hispanic and non-Hispanic African American families were recruited to evaluate the generalizability of previous results obtained with non-Hispanic white samples (12–14). Exclusion criteria were the presence of severe food allergies or chronic illnesses affecting food intake, dislike of ≥2 of the foods for which portion size was manipulated, and self-reported previous diagnosis of maternal depression or eating disorders.

Measures

Maternal and child BMI scores were calculated on the basis of measured height and weight obtained by trained nurses. Height was measured in triplicate to the nearest 0.1 cm with a stadiometer with the subjects shoeless, and weight was measured in triplicate with the subjects shoeless and in light clothing to the nearest 0.1 kg with an electronic balance. Child BMI percentiles and *z* scores were calculated with age- and sex-specific reference data (20). Child overweight was defined according to Centers for Disease Control and Prevention guidelines as a BMI ≥95th percentile. Maternal BMI was calculated as weight (kg)/height squared (m).

Demographic information was obtained by self-report and included child and maternal race-ethnicity, maternal education, and employment. The 6-item short version of the US Department of Agriculture Food Insecurity Module was used to assess household food insecurity, defined as the limited availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways (21). Items were given an affirmative (1) or negative (0) score, and responses were summed. Three categories of household food insecurity were used: scores of 0 or 1 were categorized to indicate secure households, scores between 2 and 4 indicated low food security, and scores of 5 or 6 indicated very low food security.

Experimental menu

The experimental menus for the children and mothers are shown in **Table 1**.

Portion-manipulated foods

Foods for which portion size was manipulated were macaroni and cheese, apple juice, graham crackers, chicken, rice (mothers only), and cereal. These foods were familiar (85–95% of children and 95–100% of mothers reported having eaten foods previously) and acceptable to the participants (90–98% of children and 95–100% of mothers rated foods as being "okay" or "liked"; 22, 23). The reference portions were specified by using previous research (13, 14, 24) and the 50–75th percentiles of intake for individual foods per eating occasion from the Continuing Survey of Food Intakes of Individuals, 1994–1996 (25) as guides; the reference portions of several of the foods were increased from the initial specification as the result of pilot testing.

Other foods served during the 24-h period

All other foods were served in generous amounts at meals and snacks. The portion sizes of these foods were held constant across conditions to evaluate the effects of a large entrée and snack portions on the intake of other accompanying foods.

Energy provided

Doubling the portion size of several entrées and an afternoon snack in the large-portion condition provided 47% more total energy to children and 45% more total energy to mothers than in the reference condition. Portion-manipulated foods provided 64% of total energy offered to children and 62% of total energy offered to mothers in the large-portion condition. Total energy offered to children and mothers was compared with participants' estimated energy requirements (EERs) based on sex, age, measured weight and height, and an assumed low activity level (given the confinement of subjects to the dormitory-like setting for the duration of each 24-h visit) (26). Total energy offered to children was 184% of the mean EER in the reference condition and 270% of the mean EER in the large-portion condition. Similarly, total energy offered to mothers was 180% of the mean EER in the reference condition and 262% of the mean EER in the large-portion condition.

Procedures

All procedures took place at the Children's Nutrition Research Center, Houston, TX. Potential participants were screened for inclusion by phone interview. Each mother and child came to the laboratory for an initial visit to obtain informed consent, to familiarize children with the setting, and to obtain preference ratings for menu foods. Mothers provided consent for their own participation and their child's participation. The mothers were told that the purpose of the study was to evaluate their children's food preferences and intake patterns and that their own intake patterns would be measured to provide background information. Data collected at the end of the study indicate that mothers generally perceived the child to be the focus of study: less than half of the mothers (28 of 59) made reference to their own eating in describing the study purpose (ie, "to study the eating patterns of children of different ethnicity"), and almost one-third (9 of 28) of those who did believed the study to involve parent-child similarities in food preference (ie, "to observe food preference in children in comparison to the mothers"). The staff did not inform the participating children that their food intakes were being measured.

TABLE 1
Experimental menu[1]

		Child		Mother	
	Energy density	Reference portions	Large portions	Reference portions	Large portions
	kcal/g	*kcal*		*kcal*	
Day 1					
Morning snack					
Grapes	0.71	46	46	85	85
Goldfish crackers	5.00	125	125	250	250
Lunch					
Macaroni and cheese[2]	1.51	453	906	604	1208
Carrots	0.43	17	17	17	17
Oatmeal cookies	4.01	200	200	300	300
Applesauce	0.43	47	47	47	47
Milk, 2% fat	0.50	120	120	120	120
Afternoon snack					
Apple juice[2]	0.47	113	226	158	316
Graham crackers[2]	4.62	185	370	277	554
Dinner					
Chicken nuggets[2]	2.42	368	736	—	—
Chicken strips[2]	1.73	—	—	346	692
Rice[2]	0.80	—	—	160	320
Corn	0.81	53	53	89	89
Dinner roll	2.71	108	108	217	217
Butter	7.17	—	—	72	72
Dinner salad	0.09	—	—	5	5
Dressing	4.16	—	—	67	67
Pears	0.71	80	80	80	80
Milk, 2% fat	0.50	120	120	—	—
Evening snack					
Sandwich cookies	5.00	51	51	153	153
Vanilla ice cream	1.97	160	160	160	160
Chocolate milk	0.83	—	—	199	199
Day 2					
Breakfast					
Oat ring cereal[2]	4.00	160	320	320	640
Bacon	5.76	35	35	69	69
Banana	0.92	86	86	86	86
Orange juice	0.45	54	54	108	108
Milk, 2% fat	0.50	120	120	120	120
Total energy provided (kcal)		2727	4006	4109	5974
Portion-manipulated foods (kcal)		1279	2558	1865	3730
Dietary reference intake (%)		184	270	180	262

[1] Estimated energy requirements are based on sex, age, activity level (assuming a low active physical activity level), and measured weight and height (26).
[2] Portion-manipulated food.

For each of two 24-h periods of observation, the mother-child pairs arrived at the Center at 0930 and left the following morning at the same time. The midmorning admission and discharge times were chosen to allow flexibility in family arrival time. The children and mothers ate meals and snacks separately from one another. Three to 4 children who did not know one another were seated together with a research staff member who facilitated non-food related conversation, ensured that foods were not shared, and accounted for dropped or spilled food. This aspect of the design was consistent with previous studies (13, 14, 24) and avoided the discomfort (and low intake) often observed in the laboratory when children eat alone. Alternatively, mothers ate meals and snacks individually to avoid social influences introduced by eating in the presence of unfamiliar women (27, 28). Participants were informed that they could eat as much or as little as desired during each meal and snack. Twenty minutes were allotted for each eating occasion.

The amount and nature of the structured and unstructured noneating activities occurring during the two 24-h periods were similar. Mothers completed questionnaires (administered in Spanish for 17 of the participants) on a wide range of topics, including demographics, food insecurity, child feeding practices, children's food preferences, and their own eating behavior. Children participated in structured interviews, group craft activities, board games, and a once daily movie showing. Family free-time periods were offered during the early afternoon (1330–1430) and evening (after 1815).

Families were compensated for completing the full protocol: two 24-h conditions as well as an initial 3-h visit were used primarily to familiarize families to the setting. All procedures were approved by the Baylor College of Medicine

Institutional Review Board and executed according to its standards.

Statistical analyses

Data analyses were performed with SAS (version 9.1; SAS Institute, Cary, NC). Descriptive statistics including the mean, median, SD, and range were generated. Data are presented as means ± SDs with statistical significance set at $P < 0.05$, unless otherwise indicated. Child and maternal data were analyzed separately. The primary outcomes of interest were energy consumed from the portion-manipulated foods and cumulative energy intake over the 24-h period. Dependent *t* tests were used to evaluate, across conditions, differences in energy intake from portion-manipulated foods and other foods at meals and snacks. Bonferroni correction was used to adjust the *P* value based on the number of tests performed. Sequential dependent *t* tests with Bonferroni correction were used to identify the first eating occasion at which, across conditions, differences in cumulative energy intake from portion-manipulated foods and other foods were apparent. Potential correlates of changes in food and total energy intake were tested cojointly by analysis of variance: sex, ethnicity, condition order, BMI (*z* scores used for children), and food insecurity. The number of foods for which ≥95% of the reference portion was consumed was included in the model predicting changes in foods intake. The number of portion-manipulated foods for which intake increased across conditions was also evaluated as a predictor of changes in total energy intake. Correlations were used to evaluate the relations between maternal and child changes in food and energy intake across conditions.

RESULTS

Data from one mother-child pair were excluded from the analyses because the child complained of a toothache and was observed to have a loose tooth for the duration of one of the visits. Data from 58 children and 58 mothers were analyzed.

On average, mothers were in their 30's (age: 30 ± 5 y); half reported being currently employed (55%) and having a high school education or less (53%). A greater number of African American than Hispanic mothers reported being employed (21 of 28 African American mothers compared with 10 of 30 Hispanic mothers; $P < 0.01$) and having an education beyond high school (20 of 28 African American mothers compared with 7 of 30 Hispanic mothers; $P < 0.001$). More than one-third of the mothers (8 African Americans, 14 Hispanics) reported low household food security; most of these mothers (4 African Americans, 11 Hispanics) scored in the less extreme category of food insecurity. BMI scores indicated that the mothers were, on average, obese (BMI = 34 ± 9), and their children were of normal weight (BMI percentile = 60 ± 29%).

Children's intake of portion-manipulated foods

Among children, doubling the portion size of the entrées and snack increased the energy intake from those foods by an average of 23% (180 kcal) relative to the intake in the reference condition (777 ± 224 compared with 957 ± 306 kcal; $P < 0.0001$). Significant increases in intake were seen for 2 of the 5 individual foods for which the portion size was doubled (**Table 2**). Nonparametric analysis showed that most of the 58 children ($n = 42$) had some increase (>0 g) in their intake of ≥3 of the 5 foods for which portion size was doubled.

Portion size effects did not reflect a restriction of food intake in the reference condition. Children consumed, on average, less than two-thirds (63 ± 19%) of the reference portions of the 5 manipulated foods, ranging from 50 ± 28% of the macaroni and cheese to 73 ± 26% of the chicken nuggets. Of 58 children, the number eating ≥95% of the reference portions was as follows: macaroni and cheese ($n = 7$), apple juice ($n = 29$), graham crackers ($n = 13$), chicken nuggets ($n = 17$), and cereal ($n = 23$).

Across-condition increases in children's energy intake from the portion-manipulated foods were not associated with the number of foods for which the child consumed ≥95% of the reference portion ($P = 0.74$). Across-condition changes in energy intake from the portion-manipulated foods were also unassociated with condition order ($P = 0.90$), sex ($P = 0.17$), child ethnicity ($P = 0.66$), child BMI *z* score ($P = 0.77$), or household food insecurity ($P = 0.77$).

Maternal intake of portion-manipulated foods

Among mothers, doubling the portion size of the entrées and snack increased energy intake from those foods, on average, by 21% (≈270 kcal) relative to intake in the reference condition (1284 ± 247 compared with ± 380 kcal; $P < 0.0001$). Significant increases in consumption were observed for 3 of the 6 individual foods for which portion size was doubled (Table 2). Nonparametric analysis showed that 47 of 58 mothers had some increase (>0 g) in the consumption of ≥3 of the 6 foods for which portion size was doubled.

Mothers consumed, on average, more than two-thirds (71 ± 13%) of the reference portions, ranging from 60 ± 24% of the macaroni and cheese to 81 ± 22% of the chicken. The number of mothers eating ≥95% of the reference portions was as follows: macaroni and cheese ($n = 5$), apple juice ($n = 26$), graham crackers ($n = 28$), chicken strips ($n = 22$), rice ($n = 17$), and cereal ($n = 14$). Across-condition changes in the amount of energy consumed from the portion-manipulated foods were not associated with the number of foods for which the mother consumed ≥95% of the reference portion ($P = 0.44$).

Changes in maternal energy intake of portion-manipulated foods across conditions were also unrelated to condition order ($P = 0.59$), maternal ethnicity ($P = 0.43$), maternal BMI ($P = 0.75$), maternal education ($P = 0.66$; greater than a high school education compared with less), and household food insecurity ($P = 0.33$).

Association of maternal with child intake changes

Maternal and child responses to the portion size manipulations were unrelated. This was the case whether the response was expressed as mean change in energy intake from the portion-manipulated foods ($r = -0.20$, $P = 0.13$) or as the number of foods for which consumption increased when the portion size was doubled (Spearman's $r = -0.05$, $P = 0.70$). Changes in maternal and child intakes of individual foods were also not correlated (data not shown).

Children's cumulative energy intake over the 24-h period

Cumulative energy intakes from portion-manipulated and other foods in the reference and large-portion conditions are shown in **Figure 1**. Across-condition differences in children's

TABLE 2
Intakes of portion-manipulated foods and other foods[1]

	Child		Mother	
	Reference portions	Large portions	Reference portions	Large portions
	kcal		*kcal*	
Morning snack				
Portion-manipulated	—	—	—	—
Other	101 ± 52	103 ± 54	242 ± 77	221 ± 92
Lunch				
Portion-manipulated				
Macaroni and cheese	226 ± 125	239 ± 118	363 ± 146	424 ± 185[2]
Other	170 ± 95	167 ± 86	289 ± 128	251 ± 141
Afternoon snack				
Portion-manipulated				
Apple juice	81 ± 37	81 ± 59	120 ± 45	168 ± 87[3]
Graham crackers	94 ± 66	115 ± 92	211 ± 79	247 ± 137
Other	—	—	—	—
Dinner				
Portion-manipulated				
Chicken	267 ± 96	357 ± 143[3]	279 ± 75	367 ± 128[2]
Rice	—	—	109 ± 44	128 ± 63
Other	136 ± 71	125 ± 62	401 ± 114	365 ± 108
Evening snack				
Portion-manipulated	—	—	—	—
Other	175 ± 44	157 ± 59	346 ± 109	325 ± 123
Breakfast				
Portion-manipulated				
Cereal	108 ± 59	163 ± 101[3]	203 ± 95	218 ± 103
Other	140 ± 50	130 ± 47	256 ± 75	250 ± 83

[1] All values are $\bar{x}$ ± SD. Paired *t* tests with Bonferroni corrections were used to compare child (10 comparisons) and maternal (11 comparisons) energy intake from portion-manipulated foods and other foods across reference and large-portion conditions.
[2,3] Significantly different from reference portions (Bonferroni adjusted): [2] $P < 0.05$, [3] $P < 0.001$.

cumulative energy intake from the portion-manipulated foods were not evident until the dinner meal (Figure 1A). By dinner, children had consumed 125 ± 191 kcal more from the large-portion entrées and snack than from the reference portions ($P < 0.001$). At the end of the 24-h period, children had consumed 180 kcal more from the large entrée and snack portions than from the reference portions of those foods ($P < 0.0001$).

By the end of the 24-h period, children had consumed 41 kcal less from other foods in the large-portion condition than in the reference condition, but this difference was not statistically significant (723 ± 195 kcal in the reference condition compared with 682 ± 169 kcal in the large-portion condition). As a result, serving large portions at multiple meals produced a net increase of ≈140 kcal over the period of observation, which represented an increase in the children's total energy intake of 12 ± 22% ($P < 0.001$). The effect of portion size on total energy intake varied widely among children, ranging from a 31% decrease to a 96% increase across reference and large-portion conditions.

Change in total energy intake was positively associated with the number of foods for which children showed increased intake when food portion size was doubled ($P < 0.001$). Alternatively, changes in total energy intake were unassociated with condition order ($P = 0.06$), sex ($P = 0.73$), ethnicity ($P = 0.07$), child BMI *z* score ($P = 0.43$), and household food insecurity ($P = 0.49$).

Total energy intake in the reference condition was 1500 ± 359 kcal, ≈100% of estimated daily requirements calculated for each child based on sex, age, activity (assuming a low active physical activity level), and measured weight and height (26). Total energy intake in the large-portion condition was 1639 ± 378 kcal, ≈109% of estimated daily requirements.

Maternal cumulative energy intake over the 24-h period

As depicted in Figure 1B, the effects of large portions on maternal energy intake were evident at the first meal at which large portions were served. Mothers consumed 61 kcal more from the lunch entrée in the large-portion condition than in the reference condition (Table 2). Intake of the portion-manipulated foods was also greater in the large-portion condition than in the reference condition at the afternoon snack and at the dinner meal. By the end of the 24-h period, energy intakes from the large entrées and snack were 267 ± 337 kcal greater than those from the reference condition ($P < 0.0001$).

Decreases in maternal energy intake from nonmanipulated foods were also apparent at the lunch meal (Figure 1B). By the end of the 24-h period, the cumulative reduction in energy intake from the nonmanipulated foods reached 122 ± 243 kcal (1535 ± 298 compared with 1413 ± 320 kcal in the reference and large-portion conditions, respectively; $P < 0.001$). Maternal intake of nonmanipulated high-energy-density foods (>4.0 kcal/g) was lower in the large-portion condition than in the reference condition (473 ± 144 compared with 420 ± 150 kcal; $P < 0.001$). Maternal energy intake of nonmanipulated low-energy-density foods (≤1.0 kcal/g) and medium-energy-density foods (1.1–4.0 kcal/g), however, did not differ across conditions (data not

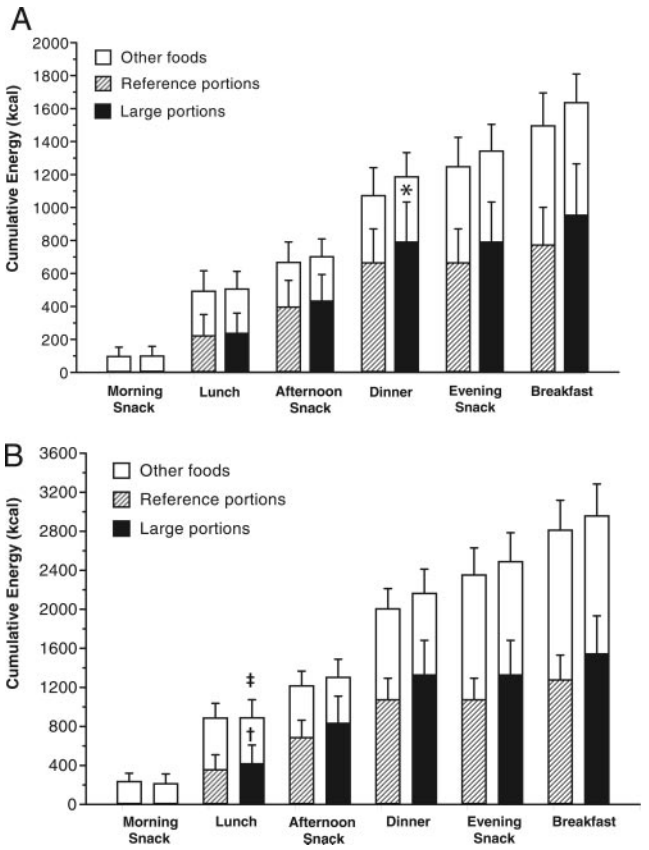

FIGURE 1. Mean (±SD) cumulative energy intakes from portion-manipulated foods and other foods in the reference and large-portion conditions. Sequential paired *t* tests with Bonferroni corrections identified eating occasions at which across-condition differences in child (A) and maternal (B) cumulative energy intakes were first apparent. *Across-condition differences in children's cumulative energy intake from portion-manipulated foods were first apparent by dinner (adjusted $P < 0.001$) and increased to 180 kcal by the end of the 24-h period ($P < 0.0001$). Across-condition differences in children's cumulative energy intake from other foods were not significant at any point during the 24-h period. †Across-condition differences in maternal cumulative energy intake from portion-manipulated foods were first apparent at lunch (adjusted $P < 0.05$) and increased to 267 kcal by the end of the 24-h period ($P < 0.0001$). ‡Across-condition differences in maternal cumulative energy intake from other foods were first apparent at lunch (adjusted $P < 0.05$) and reached −122 kcal by the end of the 24-h period ($P < 0.001$).

shown). As a result of decreases in maternal intake of nonmanipulated foods, the net increase in total energy intake across reference and large-portion conditions was 146 kcal, which represented a 6 ± 18% increase ($P < 0.01$).

Change in total energy intake across conditions was positively associated with the number of foods for which mothers had an increased intake when the portion size was doubled ($P < 0.0001$). Alternatively, changes in total energy intake were unrelated to condition order ($P = 0.27$), maternal ethnicity ($P = 0.54$), maternal BMI ($P = 0.27$), education ($P = 0.84$; greater than a high school education versus less), and household food insecurity ($P = 0.79$).

Total energy intake in the reference portion condition was 2819 ± 502 kcal, 23% higher than estimated daily requirements based on sex, age, activity (assuming a low physical activity level), weight, and height (26). Intake in the large-portion condition was 2965 ± 616 kcal, 29% higher than estimated needs.

DISCUSSION

Marketplace trends in food portion size have led to concerns that large portions are contributing to the problem of pediatric overweight (3, 6, 9, 29). Previous studies of children ranging from 2 to 9 y of age have shown 13–16% increases in total energy intake at a single meal when the entrée portion size was doubled (13, 14, 24). The findings of this study provide the first experimental data showing effects of portion size on young children's energy intake, beyond individual meals, on daily energy intake. Doubling the portion size of several entrée and an afternoon snack served during a 24-h period increased children's total energy intake by 12%. This effect was observed even though the amount of energy available to children in the reference condition was considerably higher than their estimated energy needs (184%). As in previous studies (13, 14, 24), children's intake of other foods served at the meals and snacks did not differ across conditions. Taken together, these findings suggest that large food portions contribute to obesigenic dietary environments by increasing children's daily energy intake.

Doubling the entrée and snack portions increased children's energy intake from those foods by 23% even though children, on average, did not consume the smaller portions in full. Although the portion size manipulations collectively increased children's energy intake, effects were variable both between individuals and between different types of foods. The 5 foods for which portion size was manipulated were of varied energy density and shape, with some amorphous (eg, macaroni and cheese) and others more clearly defined in units (eg, chicken nuggets). Children showed significant increases in intake of 2 of the medium-energy-density foods, one a unit food and the other amorphous. In previous research, doubling the portion size of a macaroni and cheese entrée served at a meal increased young children's food intake by 25–60% (12–14, 24). Why portion size affected children's intake of some foods but not others, particularly macaroni and cheese, is not obvious. The macaroni and cheese reference portion was 50–125 g greater than that used in previous studies (12–14, 24). It is possible that the large size of the reference portions negated effects of further increases to portion size. Although most children were familiar with and liked the portion-manipulated foods, it is also possible that unmeasured aspects of palatability and/or children's experience with the foods may have been a factor.

Portion size effects on adult intake have been shown at single meals in laboratory (30–37) and naturalistic settings (38) for unit (30, 36, 39) and amorphous (31) foods, beverages (37), foods of varying energy density (34, 35), prepackaged snacks (33), and first-course salads (32). In the present study, the mothers consumed 21% more energy from the larger food portions than from the reference portions. The fact that mothers ate, on average, less than three-quarters of the reference portions suggests that the size of the smaller portions was not artificially limiting. The 3 foods for which maternal intake increased when large portions were served were of low- to medium energy density and included a beverage, an amorphous food, and a unit food. Mothers showed evidence of compensatory decreases in the intake (≈125 kcal) of primarily high-energy-density (>4.0 kcal/g) foods served throughout the 24-h period. These adjustments, however, were insufficient to offset energy intake from the large food portions. The net increase of 6% (146 kcal) in total energy intake observed in this study is somewhat smaller than what has been observed in

previous studies. One study observed a 16% (335 kcal) increase in daily energy when all food and beverage portions were increased by 50% during a 2-d period (15). It is important to note that the current study manipulated the portion sizes of only 6 foods, approximately one-fourth of those offered to mothers. That a majority of mothers assigned the highest possible preference rating to each food (with the exception of applesauce; 45% of mothers gave it the highest rating) and rice (62%) suggests that the size of the effects were not likely attributable to a low acceptance of the menu. Finally, the observed 144 kcal increase in maternal daily energy is greater than the 50–100 daily calories that are thought to separate weight maintenance from weight gain for most adults (4).

Previous experimental investigations of portion size among children have involved predominately non-Hispanic white children. The present findings extend that work by demonstrating effects among Hispanic and African American children—2 ethnic groups disproportionately affected by overweight (2). In this study, the effects of portion size on total energy intake did not vary by ethnicity in children or in their mothers. The failure to observe ethnic differences in portion size effects does not imply that cultural influences are irrelevant for understanding the role of portion size in pediatric obesity. Although the effects of portion size on intake may be similar across ethnicities, factors that dictate the extent to which children (and mothers) have routine exposure to large portions may have a cultural component. For instance, children's consumption of fast food, a noted source of exposure to excessive marketplace portions, varies by ethnicity as well as by income (40, 41). Research is needed to understand cultural and socioeconomic influences on the frequency with which children encounter large food portions at and away from home.

Finally, large individual differences were observed in children's and mothers' responses to portion size. Consistent with previous experiments in children (13, 14, 24) and adults (31), effects of portion size on intake did not vary by weight status. Furthermore, child and maternal intake of large portions were unrelated. Previous twin and sibpair studies have reported similarities in energy intake among family members (42, 43). In one study of 32 sibpairs aged 3–7 y, total energy intake, but not caloric compensation, showed familial aggregation (42). Why maternal and child scores were unrelated in the present study is not clear. Children ate in groups separately from their mothers to ensure that effects of portion size on daily intake were not biased by adult directives to eat. Given that families were recruited from Head Start programs, we believe that it is not unusual for these children to eat in small groups apart from their mothers. It is possible, however, that this aspect of the design removed child feeding interactions and/or food modeling behavior (44) that might otherwise produce similarities in the amount of food consumed between mother and child. That children ate in social groups while their mothers ate alone prohibited comparison of the data in absolute terms but did not preclude assessment of the relative association between maternal and child scores. As such, these findings do not provide evidence that portion size effects on children's eating are driven by weight status or a familial-based susceptibility to overconsume large portions.

In conclusion, the findings of this research suggest that large portions contribute to obesigenic dietary environments by promoting daily energy intake among low-income Hispanic and African American mothers and their preschool-aged children. Increases in cumulative energy intake across conditions emerged almost immediately for mothers, were observed by dinner time for children, and persisted over the course of the 24-h period for both. The external validity of this work is supported by the observation that large food portions are pervasive in the market place (41). The generalizability of the findings to other socioeconomic and ethnic groups, however, merits further consideration. Prospective observational studies evaluating the association of children's exposure to large portions with energy intake and weight gain are needed to inform scientific knowledge of the contribution of large portions to pediatric obesity.

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