

# The association of fast food consumption with poor dietary outcomes and obesity among children: is it the fast food or the remainder of the diet?<sup>1–3</sup>

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## ABSTRACT

**Background:** Although fast food consumption has been linked to adverse health outcomes, the relative contribution of fast food itself compared with the rest of the diet to these associations remains unclear.

**Objective:** Our objective was to compare the independent associations with overweight/obesity or dietary outcomes for fast food consumption compared with dietary pattern for the remainder of intake.

**Design:** This cross-sectional analysis studied 4466 US children aged 2–18 y from NHANES 2007–2010. Cluster analysis identified 2 dietary patterns for the non-fast food remainder of intake: Western (50.3%) and Prudent. Multivariable-adjusted linear and logistic regression models examined the association between fast food consumption and dietary pattern for the remainder of intake and estimated their independent associations with overweight/obesity and dietary outcomes.

**Results:** Half of US children consumed fast food: 39.5% low-consumers ( $\leq 30\%$  of energy from fast food) and 10.5% high-consumers ( $> 30\%$  of energy). Consuming a Western dietary pattern for the remainder of intake was more likely among fast food low-consumers (OR: 1.51; 95% CI: 1.24, 1.85) and high-consumers (OR: 2.21; 95% CI: 1.60, 3.05) than among nonconsumers. The remainder of diet was independently associated with overweight/obesity ( $\beta$ : 5.9; 95% CI: 1.3, 10.5), whereas fast food consumption was not, and the remainder of diet had stronger associations with poor total intake than did fast food consumption.

**Conclusions:** Outside the fast food restaurant, fast food consumers ate Western diets, which might have stronger associations with overweight/obesity and poor dietary outcomes than fast food consumption itself. Our findings support the need for prospective studies and randomized trials to confirm these hypotheses. *Am J Clin Nutr* 2014;99:162–71.

## INTRODUCTION

The prevalence of obesity among US children increased significantly during the past 3 decades, with  $\sim 1$  in 3 overweight or obese by 2009–2010 (1–3). Concurrent with these trends, children's fast food intake has increased markedly since the 1970s (4–7). The percentage of children's total energy intake consumed from fast food restaurants increased from 2% in 1977–1978 to 13% in 2003–2006 (6, 7). By 2007–2008, 33% of children and 41% of adolescents consumed foods or beverages from fast food restaurants (hereafter referred to as fast foods) on a typical day (8). Many scholars focus on fast food as a key

contributor to the rising prevalence of obesity because of fast food's poor nutritional quality (9–11): fast foods are higher in solid fat (23.9% of total energy) than in foods consumed from retail food stores (17.6%) or schools (20.9%) (12), and few items on fast food children's menus align with national nutrition standards or dietary guidelines (9, 10, 13–15). Compared with nonconsumers, children who consume fast food have higher total energy, total fat, and saturated fat intakes; have lower fiber intakes; and consume diets with higher energy density (16–21). Fast food consumption is also associated with higher intake of sugar-sweetened beverages (SSBs) and French fries and lower intake of milk, fruit, and vegetables (16–18, 20, 21). Frequent fast food consumption was associated with weight gain in prospective studies among adults (22–25), with more limited evidence among youth (26, 27).

However, several studies note that fast food intake might be correlated with other factors, including individual dietary preferences for certain foods, access to fast food restaurants or supermarkets, and income or time constraints, which influence how individuals eat throughout the remainder of the day (20–22, 28, 29). Scholars hypothesize that fast food consumers might therefore have less healthy dietary patterns, even outside the fast food restaurant (28–31). Thus, consumption of fast food might not be directly associated with increased energy intake and weight gain, but might instead be a marker for other unhealthy behaviors associated with these outcomes (30). However, these hypotheses have not been tested among children. It is unknown whether particular subgroups of children are more likely to have both high fast food consumption and an unhealthy dietary pattern for the remainder of intake and how these behaviors are jointly and independently associated with weight status. Moreover,

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many researchers caution that associations between fast food consumption and obesity might be overestimated if studies do not control for confounding by food choices outside the fast food restaurant, yet recent literature reviews concluded that no studies included this essential adjustment (20–22, 29, 30). Thus, the potential effect of public health efforts targeted at fast food might be overstated as well (29).

To address these gaps in the research literature, this study aimed to determine whether fast food consumers also eat poorly outside of the fast food restaurant and to compare the independent associations of fast food consumption compared with dietary pattern for the remainder of intake with overweight/obesity prevalence and dietary outcomes.

## SUBJECTS AND METHODS

### Dietary assessment

This cross-sectional analysis included 4466 US children aged 2–18 y participating in the 2007–2010 NHANES. NHANES and its dietary interview component, What We Eat in America, use a stratified, multistage complex survey design to provide nationally representative estimates of dietary intake and prevalence of health outcomes for the civilian, noninstitutionalized US population. A complete description of the survey design is available elsewhere (32, 33). Briefly, two 24-h dietary recalls were conducted by using the USDA's Automated Multiple-Pass Method. Recalls were collected by trained interviewers in-person in a mobile examination center (day 1) and 3–10 d later by phone (day 2). A proxy respondent completed dietary recalls for children aged <6 y, and recalls for children aged 6–12 y were proxy-assisted. Both days of recall were used to more fully represent fast food intake, which is episodically consumed (22).

### Anthropometric measurements and covariate assessment

In-person interviews were used to collect demographic and socioeconomic data, including sex, age, race-ethnicity, household income, and parental education level. Weight and height were measured during a physical examination at the mobile exam center (34, 35), and BMI was calculated as weight in kilograms divided by height in meters squared. Using the CDC's 2000 sex-specific BMI-for-age growth charts, overweight was defined as BMI at or above the 85th percentile but below the 95th percentile, and obesity was defined as BMI at or above the 95th percentile (36).

### Analytic sample

This study included children with 2 d of dietary recall deemed reliable by survey administrators, complete covariate data, and measured weight and height. Children were excluded if missing information on food source for any energy-containing item ( $n = 43$ ). Because this analysis focuses on the segment of the diet outside the fast food restaurant, we also excluded children who consumed only fast food for an entire day ( $n = 11$ ). This secondary data analysis was exempt from institutional review board approval.

### Fast food consumption

For every food or beverage reported, the interviewer recorded the location where the food item was obtained. All items obtained from a fast food restaurant, defined by NHANES as any dining establishment without waiters/waitresses, were classified as fast food. Degree of fast food consumption was defined based on the 2-d mean percentage of daily energy consumed from items whose source was reported as fast food restaurants. Based on the shape of the curvilinear relation between the percentage of energy from fast food and overweight/obesity or dietary outcomes, cutoffs were determined to classify children as nonconsumers (0% of energy from fast food), low-consumers (0.1–30%), and high-consumers (>30%) of fast food. The remaining segment of the diet not obtained from fast food restaurants was used in dietary pattern analysis to describe how children eat during the remainder of the day.

### Food grouping

Each food or beverage was recorded by using a discrete food code and matched to nutrient information from the USDA's Food and Nutrient Database for Dietary Studies versions 4.1 (2007–2008) and 5.0 (2009–2010) (37). Food codes were aggregated into 55 mutually exclusive, nutritionally meaningful food and beverage groups based on dietary behaviors and consumption patterns as previously described (38, 39). Beverages were categorized separately based on their differential effects on satiety and weight gain (40, 41). Food groups were disaggregated as high- or low-saturated fat by using cutoffs based on the International Choices Program for food labeling because US dietary guidelines apply to total intake but not individual food groups (42).

### Dietary pattern analysis for the remainder of intake

To represent the remainder of diet outside the fast food restaurant, we aimed to identify categorical groups of children with distinct dietary patterns, as suggested by our hypothesis that the non-fast food segment of diet is different for fast food consumers compared with nonconsumers. Therefore, cluster analysis was selected as the method best suited for this aim. Cluster analysis is a method that defines mutually exclusive groups (or clusters) of individuals to maximize differences between groups while minimizing the differences within groups. All items not obtained from fast food restaurants were included in cluster analysis to identify dietary patterns for the remainder of intake, reflective of how children ate outside the fast food restaurant. We aimed to identify food and beverage groups (hereafter referred to as food groups) representative of overall dietary patterns for non-fast foods, rather than to provide a detailed description of these patterns. Cluster analysis was thus restricted to a limited number of food groups with established associations with obesity (43–45). Additional consideration was given to weighted percentages of consumers for each food group and weighted mean intake (46). Food groups sharing consumption patterns and nutritional characteristics were combined; for example, grain-based desserts and dairy-based desserts were merged into a single dessert category. Food groups were further combined based on their ability to define distinct patterns and on interpretability of the aggregated food group. For example, milk

was combined into a single group because one cluster had a greater intake of both high- and low-fat milk, aggregation did not meaningfully affect the composition of clusters, and pattern interpretation was unchanged. After this exploration, 21 food groups were included in cluster analysis, representing all foods and beverages reported by study participants from locations other than fast food restaurants. A description of this food grouping system is provided elsewhere (*see* Supplemental Table 1 under “Supplemental data” in the online issue).

The relative contribution of each food group to the remaining portion of diet, expressed as the 2-d mean percentage of non-fast food energy intake from each of the 21 food groups, was used to account for differing total energy intake among children of different ages. Food group variables were standardized as continuous  $z$  scores to create comparability between food groups with differing contributions to total intake and differing amount of variability. For fast food nonconsumers, this dietary pattern reflected total intake.

We performed cluster analysis using SAS FASTCLUS (SAS version 9.3; SAS Institute Inc) to identify groups of children with similar dietary patterns for the remainder of diet outside the fast food restaurant. This k-means procedure establishes cluster membership based on least-squares estimation with Euclidean distances and minimizes the distance among members in a cluster while maximizing the distance between clusters. Initial values used as a first guess of cluster means (cluster seeds) were randomly selected, and optimal cluster centers for that seed were obtained by conducting 1000 iterations of the clustering procedure. Because the cluster solution is sensitive to the initial seed, clustering was repeated for 100 random initial seeds (47). To maximize the ratio of between-cluster variance to within-cluster variance [ $R^2/(1 - R^2)$ ], we identified the optimal cluster solution with maximal  $R^2$ .

To determine the most appropriate number of clusters, we compared cluster characteristics for increasingly differentiated cluster solutions, increasing from 2 to 5 clusters. If the more differentiated solution did not separate the cluster into meaningful subgroups, the more parsimonious solution was chosen. In addition, cluster solutions were retained only if each cluster contained  $\geq 5\%$  of the total sample, which maintained reliability of within-cluster estimates. The final cluster solution identified 2 distinct clusters, which we called Prudent and Western dietary patterns according to mean  $z$  scores for food groups (*see* Supplemental Table 2 under “Supplemental data” in the online issue).

### Statistical analysis

All other analyses were conducted by using Stata 12 (Stata Corp). Stata’s survey commands were used to account for complex survey design and incorporate survey weights to generate nationally representative estimates. To test the hypothesis that fast food consumers eat differently from nonconsumers for the remainder of diet outside of the fast food restaurant, we compared mean dietary intake, excluding fast foods, among fast food nonconsumers, low-consumers, and high-consumers by using  $t$  tests with Bonferroni correction for multiple comparisons. Food groups were represented as the 2-d mean percentage of non-fast food energy intake. To determine whether fast food consumption is associated with consuming a Western dietary

pattern for the remainder of intake, we used logistic regression to estimate the odds of consuming a Western dietary pattern for low and high fast food consumers compared with fast food nonconsumers. We examined effect measure modification of this association by age group, sex, and race-ethnicity separately by using Wald chunk tests for the joint significance of interaction product terms. Interactions that were not statistically significant ( $\alpha = 0.10$ ) were not included in the final models.

To identify sociodemographic factors associated with being both a fast food consumer and consuming a Western dietary pattern for the remainder of intake, we used multinomial logistic regression with 6 outcomes defined by the combination of dietary pattern (Prudent or Western) and fast food consumption (non-, low-, and high-consumers). This model uses maximum likelihood estimation with simultaneous consideration of all outcomes.

To estimate the associations between these joint eating behaviors and health outcomes, we used multivariable-adjusted models regressing weight status (logistic model) and dietary outcomes (linear models) on fast food consumption, dietary pattern for the remainder of diet, and their interaction, with fast food nonconsumers with a Prudent dietary pattern as the common referent group. All dietary outcomes were represented as 2-d mean total intake. Separate models were estimated for overweight/obesity, total energy intake, percentage of energy from fat, fiber density (g/1000 kcal), calcium density (mg/1000 kcal), and intake (kcal/d) of SSBs, French fries, milk, fruit, and vegetables. Stata’s margins command was used to determine the adjusted outcome value for each exposure group (combination of fast food consumption and dietary pattern for the remainder of intake). A Wald test for the joint significance of the fast food dietary pattern interaction terms was conducted with  $P < 0.10$  considered significant.

Finally, we tested the hypothesis that a Western dietary pattern for the remainder of diet outside the fast food restaurant has a stronger association with weight status and dietary outcomes than fast food consumption itself. We regressed weight status (logistic model) and dietary outcomes (linear models) on fast food consumption and dietary pattern for the remainder of intake. To compare the magnitude of the associations for fast food consumption compared with dietary pattern for the remainder of diet,  $\beta$  coefficients were compared with Wald tests ( $\alpha = 0.05$ ). Models were repeated without adjustment for dietary patterns, and the unadjusted and adjusted  $\beta$  coefficients for fast food consumption were compared by using a change-in-estimate approach with  $>10\%$  change indicating confounding by dietary pattern.

All models were adjusted for sex, age (as linear and quadratic terms), race-ethnicity (non-Hispanic white, non-Hispanic black, Mexican-American, or other races/other Hispanics), income group (household income  $\leq 130\%$ , 131–185%, 186–350%, or  $>350\%$  of the Federal Poverty Level), parental education (less than high school, completed high school, some college or associate’s degree, or college graduate or above), total energy intake (age-specific quintiles), and weight status (nonoverweight/nonobese, overweight, or obese) where appropriate.

Several sensitivity analyses were performed to establish the robustness of our results. Our definition of fast food consumption did not consider its nutritional quality, yet healthy fast food options are increasingly available (48). Thus, top food group contributors to fast food intake were examined, and cluster

analysis was repeated by using intake from fast food restaurants to identify groups of children consuming healthy fast foods. Because fast food is episodically consumed and only 2 dietary recalls might overestimate the prevalence of nonconsumers, analyses were repeated by using weekly frequency of fast food meals reported by a Diet, Behavior, and Nutrition questionnaire (49, 50). Physical activity is an important potential confounder that might differ between fast food consumers and nonconsumers, yet detailed assessment was available only for adolescents and measures for younger children differed between surveys. As a sensitivity analysis, we additionally adjusted for confounding by physical activity as weekly metabolic equivalent minutes of total activity among adolescents or weekly frequency of "hard" play or exercise (2007–2008) or  $\geq 60$  min of activity (2009–2010) among younger children aged 2–11 y.

## RESULTS

Based on the 2-d mean percentage of total energy intake from fast food restaurants, 49.9% of children were nonconsumers of fast food, 39.5% were low-consumers, and 10.5% were high-consumers. Compared with nonconsumers, high-consumers had a significantly lower intake of milk, dairy, and low-fat mixed dishes and higher intake of SSBs, not only for total intake (from all locations) but also for the remaining segment of the diet excluding items from fast food restaurants (Table 1; see all food groups in Supplemental Table 3 under "Supplemental data" in the online issue). Higher intake of French fries and lower intake of fruit and vegetables were also observed among high-consumers, although differences were not consistently significant. Both low-

consumers ( $1985 \pm 30$  kcal/d) and high-consumers ( $1993 \pm 45$  kcal/d) of fast food had higher total energy intake than nonconsumers ( $1770 \pm 18$  kcal/d).

Cluster analysis of the remaining segment of diet outside the fast food restaurant identified 2 groups of children with distinct dietary patterns. One dietary pattern was characterized by lower intakes of SSBs, salty snacks, high-fat sandwiches, and candy and higher intakes of milk, fruit, low-fat mixed dishes, and dairy; this pattern was therefore referred to as a Prudent diet (see Supplemental Table 2 under "Supplemental data" in the online issue). The second dietary cluster reflected a typical Western diet, with higher intakes of SSBs, salty snacks, high-fat sandwiches, candy, and French fries. SSBs, salty snacks, milk, and fruit best differentiated the 2 clusters, with differences in absolute  $z$  scores  $\geq 0.50$ . The Prudent dietary group constituted 49.7% of the sample.

The odds of consuming a Western dietary pattern for the remainder of intake were significantly higher among fast food low-consumers (multivariable-adjusted OR: 1.51; 95% CI: 1.24, 1.85) and high-consumers (OR: 2.21; 95% CI: 1.60, 3.05) compared with fast food nonconsumers (Table 2). The multivariable-adjusted predicted prevalence of consuming a Western diet for the remainder of intake was  $43.9 \pm 1.9\%$  among fast food nonconsumers,  $54.2 \pm 2.3\%$  among low-consumers, and  $63.4 \pm 3.8\%$  among high-consumers. Interactions with age group, race-ethnicity, and sex were not significant.

Having the combination of high fast food consumption and Western diet for the remainder of intake was less likely among children aged 2–5 y (OR: 0.06; 95% CI: 0.03, 0.13) and 6–11 y (OR: 0.31; 95% CI: 0.22, 0.43) than among adolescents, more

**TABLE 1**

Total dietary intake and dietary intake excluding fast food for fast food non-, low-, and high-consumers among US children based on 2 nonconsecutive 24-h dietary recalls<sup>1</sup>

	Total intake			Intake excluding fast food <sup>2</sup>		
	Fast food nonconsumers <sup>3</sup> ( <i>n</i> = 2299; 49.9%)	Fast food low-consumers ( <i>n</i> = 1683; 39.5%)	Fast food high-consumers ( <i>n</i> = 484; 10.5%)	Fast food nonconsumers ( <i>n</i> = 2299; 49.9%)	Fast food low-consumers ( <i>n</i> = 1683; 39.5%)	Fast food high-consumers ( <i>n</i> = 484; 10.5%)
Food groups (% of energy) <sup>4</sup>						
Milk	10.3 $\pm$ 0.3 <sup>5</sup>	8.9 $\pm$ 0.3*	4.8 $\pm$ 0.3***	10.3 $\pm$ 0.3	10.3 $\pm$ 0.4	8.0 $\pm$ 0.5***
Dairy	2.4 $\pm$ 0.2	2.0 $\pm$ 0.1	1.2 $\pm$ 0.2***	2.4 $\pm$ 0.2	2.2 $\pm$ 0.2	1.4 $\pm$ 0.3**
Mixed dishes, low-fat <sup>6</sup>	7.7 $\pm$ 0.4	5.4 $\pm$ 0.4*	4.1 $\pm$ 0.5*	7.7 $\pm$ 0.4	6.1 $\pm$ 0.4*	4.9 $\pm$ 0.7*
Fruit	3.4 $\pm$ 0.2	2.8 $\pm$ 0.2	1.5 $\pm$ 0.1***	3.4 $\pm$ 0.2	3.3 $\pm$ 0.2	2.8 $\pm$ 0.4
Vegetables <sup>7</sup>	0.7 $\pm$ 0.1	0.5 $\pm$ 0.1	0.5 $\pm$ 0.1	0.7 $\pm$ 0.1	0.6 $\pm$ 0.1	0.4 $\pm$ 0.1*
SSBs <sup>8</sup>	5.6 $\pm$ 0.2	6.7 $\pm$ 0.3*	9.3 $\pm$ 0.6***	5.6 $\pm$ 0.2	7.0 $\pm$ 0.3*	11.1 $\pm$ 0.9***
French fries	0.9 $\pm$ 0.1	3.0 $\pm$ 0.2*	5.5 $\pm$ 0.3***	0.9 $\pm$ 0.1	1.1 $\pm$ 0.1	1.1 $\pm$ 0.2
Total energy (kcal/d)	1770 $\pm$ 18	1985 $\pm$ 30*	1993 $\pm$ 45*	1770 $\pm$ 18	1672 $\pm$ 25*	1132 $\pm$ 24***
Total fat (% of energy)	32.2 $\pm$ 0.2	33.1 $\pm$ 0.3	34.8 $\pm$ 0.3***	32.2 $\pm$ 0.2	31.6 $\pm$ 0.4	30.3 $\pm$ 0.5*

<sup>1</sup>Data are for children aged 2–18 y from NHANES 2007–2010. Values are nationally representative percentages and account for complex survey design and weights. \*Significantly different from fast food nonconsumers; \*\*significantly different from fast food low-consumers ( $P < 0.05$  with Bonferroni correction for multiple comparisons,  $t$  test).

<sup>2</sup>Excludes foods and beverages reported from fast food restaurants.

<sup>3</sup>Fast food consumption is defined by the 2-d mean percentage of total energy intake from fast food restaurants: nonconsumers, 0% kcal from fast food; low-consumers, 0.1–30% kcal from fast food; high-consumers, >30% kcal from fast food.

<sup>4</sup>Expressed as a percentage of total energy (total intake) or percentage of non-fast food energy (intake excluding fast food). Where indicated, food groups were separated by high and low saturated fat based on cutoffs established by the International Choices Program.

<sup>5</sup>Mean  $\pm$  SE (all such values).

<sup>6</sup>Includes dishes made with pasta, rice, grains, and/or meat, poultry, or fish.

<sup>7</sup>Includes fresh, frozen, or canned nonstarchy vegetables.

<sup>8</sup>SSBs, sugar-sweetened beverages: includes colas, fruit drinks, sports drinks, and energy drinks.

**TABLE 2**Multivariable-adjusted ORs (95% CIs) for consuming a Western dietary pattern for the remainder of diet by fast food consumption among US children<sup>1</sup>

	Fast food consumption <sup>2</sup>		
	Nonconsumer (n = 2299; 49.9%) <sup>3</sup>	Low-consumer (n = 1683; 39.5%)	High-consumer (n = 484; 10.5%)
Fast food intake (% of energy) <sup>4</sup>	0.0	15.4 (0.0, 30.0)	39.6 (30.0, 92.7)
Multivariable-adjusted OR			
Model 1 <sup>5</sup>	1.0 (reference)	1.60 (1.31, 1.96)	2.27 (1.68, 3.06)
Model 2 <sup>6</sup>	1.0	1.51 (1.23, 1.84)	2.24 (1.63, 3.08)
Model 3 <sup>7</sup>	1.0	1.51 (1.24, 1.85)	2.21 (1.60, 3.05)
Multivariable-adjusted probability of Western dietary pattern <sup>8</sup>	43.9 ± 1.9	54.2 ± 2.3	63.4 ± 3.8

<sup>1</sup>Data are for 4466 children aged 2–18 y from NHANES 2007–2010. All models account for complex survey design and are weighted to be nationally representative. Dietary patterns for the remainder of intake outside the fast food restaurant were determined by cluster analysis by using standardized z scores for the percentage of non-fast food energy intake from each food group.

<sup>2</sup>Fast food consumption is defined by the 2-d mean percentage of total energy intake from fast food restaurants: nonconsumers, 0% kcal from fast food; low-consumers, 0.1–30% kcal from fast food; high-consumers, >30% kcal from fast food.

<sup>3</sup>Values are number in sample; percentages adjusted to be nationally representative.

<sup>4</sup>Values are medians; ranges in parentheses.

<sup>5</sup>ORs (95% CIs) for Western diet comparing fast food consumers with nonconsumers (reference) derived from logistic regression models of Western dietary pattern for the remainder of diet on fast food consumption, adjusted for age (age, age<sup>2</sup>), sex, race-ethnicity (non-Hispanic white, non-Hispanic black, Mexican American, or other race-ethnicities), income (household income ≤130%, 131–185%, 186–350%, or >350% of the Federal Poverty Level), and parental education (<high school, high school, some college, or college degree).

<sup>6</sup>Model 2 was additionally adjusted for 2-d mean total energy intake (age group-specific quintiles of kcal/d).

<sup>7</sup>Model 3 was additionally adjusted for weight status (nonoverweight/obese, overweight, or obese).

<sup>8</sup>Adjusted predicted probability ± SE of having a Western dietary pattern for the remainder of diet by level of fast food consumption from logistic regression model 3.

likely among non-Hispanic blacks (OR: 2.45; 95% CI: 1.50, 4.01) than among non-Hispanic whites, and less likely among children whose parents had a college degree (OR: 0.27; 95% CI: 0.11, 0.69) than among those whose parent did not have a high school diploma (see Supplemental Table 4 under Supplemental data” in the online issue).

The multivariable-adjusted prevalence of overweight/obesity (Table 3) was significantly higher for children with the combination of high fast food consumption and a Western dietary pattern for the remainder of the intake (mean ± SD: 40.4 ± 3.4%) than for Prudent fast food nonconsumers (28.0 ± 1.4%). Children with both eating behaviors consumed significantly less milk (mean ± SD intake: 87 ± 7 kcal), fruit (21 ± 2 kcal), vegetables (7 ± 2 kcal), fiber (5.7 ± 0.1 g/1000 kcal), and calcium (479 ± 13 mg/1000 kcal); significantly more SSBs (212 ± 14 kcal), French fries (94 ± 9 kcal), and total energy (1934 ± 53 kcal); and a higher percentage of energy from total fat (34.6 ± 0.4% kcal) than did children with neither of these dietary behaviors.

Without consideration of dietary pattern for the remainder of diet, high fast food consumption was significantly associated with a higher prevalence of overweight/obesity (Table 4; β: 6.7; 95% CI: 0.2, 13.2). The relation was attenuated and nonsignificant (β: 5.6; 95% CI: -0.9, 12.1) after adjustment for dietary pattern for the remainder of diet. However, consuming a Western dietary pattern for the remainder of diet was significantly associated with a higher prevalence of overweight/obesity (β: 5.9; 95% CI: 1.3, 10.5) after control for fast food intake. The independent

associations between consuming a Western pattern for the remainder of diet and total intake of milk (β: -95; 95% CI: -105, -84 kcal), fruit (β: -39; 95% CI: -46, -32 kcal), SSBs (β: 98; 95% CI: 86, 110 kcal), dietary fiber (β: -1.7; 95% CI: -2.0, -1.5 g/1000 kcal), and calcium (β: -144; 95% CI: -162, -126 mg/1000 kcal) were significantly greater than the independent associations of these outcomes with high fast food consumption. Associations between high fast food consumption and overweight/obesity, milk, fruit, vegetables, SSBs, total energy, fiber, calcium, and fat were overestimated by >10% in models not adjusted for a Western dietary pattern for the remainder of intake, which indicates likely confounding of the association between fast food and weight status or dietary outcomes by dietary pattern outside the fast food restaurant.

Although our definition of fast food consumption did not consider its nutritional quality, supplementary analyses found that few children consumed more healthful fast foods. The top food group contributors to energy intake from fast food included pizza, hamburgers, French fries, high-fat sandwiches, and SSBs (see Supplemental Table 5 under “Supplemental data” in the online issue). When cluster analysis was repeated with intake from fast food restaurants, a cluster consuming more healthful fast foods (such as milk, fruit, vegetables, and salads) included <5% of the sample (see Supplemental Table 6 under “Supplemental data” in the online issue). Conclusions did not differ when fast food consumption was instead classified by the weekly frequency of fast food meals reported by questionnaire (see Supplemental Tables 7–9 under “Supplemental data” in the

TABLE 3

Weight status and total dietary intake by degree of fast food consumption and dietary pattern for the remainder of diet among US children<sup>1</sup>

	Prudent dietary pattern <sup>2</sup>			Western dietary pattern			<i>P</i> -interaction <sup>4</sup>
	FF nonconsumer <sup>3</sup> ( <i>n</i> = 1321)	FF low-consumer ( <i>n</i> = 792)	FF high-consumer ( <i>n</i> = 153)	FF nonconsumer ( <i>n</i> = 978)	FF low-consumer ( <i>n</i> = 891)	FF high-consumer ( <i>n</i> = 331)	
Overweight/obese (%)	28.0 ± 1.4 <sup>5</sup>	25.1 ± 2.3	31.1 ± 5.9	33.4 ± 2.0	30.8 ± 2.9	40.4 ± 3.4*	0.9
Food groups (kcal/d)							
Milk	220 ± 6	214 ± 7	149 ± 14*	128 ± 7*	109 ± 5*	87 ± 7*	0.07
Fruit	70 ± 3	74 ± 6	60 ± 5	35 ± 3*	30 ± 2*	21 ± 2*	0.5
Vegetables <sup>6</sup>	15 ± 2	15 ± 2	8 ± 3	8 ± 1*	6 ± 1*	7 ± 2*	0.09
SSBs <sup>7</sup>	69 ± 4	80 ± 6	79 ± 12	161 ± 6*	176 ± 9*	212 ± 14*	0.1
French fries	13 ± 2	47 ± 6*	116 ± 14*	27 ± 3*	67 ± 4*	94 ± 9*	0.05
Nutrients							
Total energy (kcal/d)	1746 ± 19	1932 ± 36*	1760 ± 55	1847 ± 25*	2039 ± 40*	1934 ± 53*	0.7
Fat (% of energy)	31.4 ± 0.3	31.8 ± 0.5	34.9 ± 0.8*	33.6 ± 0.4*	33.9 ± 0.3*	34.6 ± 0.4*	0.05
Fiber (g/1000 kcal)	8.2 ± 0.2	8.1 ± 0.2	7.1 ± 0.3*	6.5 ± 0.1*	6.2 ± 0.1*	5.7 ± 0.1*	0.4
Calcium (mg/1000 kcal)	651 ± 9	639 ± 11	546 ± 30*	505 ± 8*	480 ± 9*	479 ± 13*	0.02

<sup>1</sup> Data are for 4466 children aged 2–18 y from NHANES 2007–2010. All results account for complex survey design and are weighted to be nationally representative. Each outcome was included as the dependent variable in a separate logistic (overweight/obesity) or linear (dietary outcomes) regression model with fast food consumption, dietary pattern for the remainder of diet, and fast food by dietary pattern interaction terms. \*Significantly different from Prudent fast food nonconsumers (*P* < 0.05 with Bonferroni correction for multiple comparisons, *t* test). All models were adjusted for age (age, age<sup>2</sup>), sex, race-ethnicity (non-Hispanic white, non-Hispanic black, Mexican American, or other race-ethnicities), income (household income ≤130%, 131–185%, 186–350%, or >350% of the Federal Poverty Level), parental education (<high school, high school, some college, or college degree), 2-d mean total energy intake (age-group specific quintiles), and weight status (nonoverweight/obese, overweight, or obese) where appropriate. FF, fast food; SSB, sugar-sweetened beverage.

<sup>2</sup> Dietary patterns for the remainder of intake outside the fast food restaurant were determined by cluster analysis by using standardized *z* scores for the percentage of non-fast food energy intake from each food group.

<sup>3</sup> Fast food consumption is defined by the 2-d mean percentage of total energy intake from fast food restaurants: nonconsumers, 0% kcal from fast food; low-consumers, 0.1–30% kcal from fast food; high-consumers, >30% kcal from fast food.

<sup>4</sup> Wald test of joint significance of interaction product terms for low- and high fast food consumption by Western dietary pattern.

<sup>5</sup> Adjusted mean ± SE of outcome by combination of fast food consumption and dietary pattern (all such values).

<sup>6</sup> Includes fresh, frozen, or canned nonstarchy vegetables.

<sup>7</sup> Includes colas, fruit drinks, sports drinks, and energy drinks.

online issue) or when models were additionally adjusted for physical activity (see Supplemental Tables 10–12 under “Supplemental data” in the online issue).

## DISCUSSION

To the best of our knowledge, this study was the first to examine whether obesity and the poor dietary outcomes linked with fast food intake are more strongly associated with the actual fast food or the remainder of diet. In this nationally representative sample, low and high fast food consumers ate less healthfully outside the fast food restaurant and were 1.5 and 2.2 times as likely to consume a Western dietary pattern for the remainder of diet, respectively, compared with nonconsumers. Adolescence, black race-ethnicity, and lower parental education were associated with having both high fast food consumption and a Western dietary pattern for the remainder of intake, a combination associated with a higher likelihood of being overweight/obese. Considering both eating behaviors, the remainder of the diet, but not fast food per se, was associated with overweight/obesity, and diet outside the fast food restaurant had a stronger relation with poor dietary outcomes than did fast food consumption itself. Associations between fast food intake and these health outcomes were overestimated without adjustment for the remainder of intake.

Little research has been conducted to study the remainder of fast food consumers' diets and to understand whether this may

compensate for poor dietary intake at the fast food restaurant (51). Studies have focused solely on total dietary intake, finding less healthful consumption among fast food consumers (16–21). We showed that, in our sample of US children, high fast food consumers had a lower intake of milk, dairy, and vegetables and a higher intake of SSBs outside of the fast food restaurant and that low and high fast food consumption were associated with having a Western diet for the remainder of intake. Our results are consistent with prior findings that frequency of fast food intake was associated with greater availability of soda and chips in the home and a lower likelihood of being served vegetables or milk with home meals (17, 31).

The need to determine whether associations of fast food consumption with total diet and overweight/obesity are attributable specifically to foods consumed from fast food restaurants or to poor dietary choices at other times is a major gap in studying the health effects of fast food consumption (17, 22, 24, 30). Dietary preferences, access to food sources, food prices, and time constraints are critical influences not only on the choice to consume fast foods, but also on dietary intake outside the fast food restaurant (20–22, 28, 29). Several studies accounted for the differences between fast food consumers and nonconsumers by using a within-subjects cross-sectional design, comparing a day with fast food consumption with one without or by using fixed-effects models to isolate the associations with changes in fast food intake while holding constant other unhealthy behaviors. These studies consistently found that fast food consumption

was associated with higher total energy intake and lower dietary quality (16, 20, 21, 29).

However, these approaches control for, rather than explore, the differences between fast food consumers and nonconsumers. By explicitly modeling the dietary pattern of the remainder of intake, we were able to compare the associations with total dietary intake for fast food consumption compared with the rest of the diet. In

agreement with previous studies that used within-person analysis (16, 20, 21, 29), we found that high fast food consumption was associated with poor dietary outcomes, even after adjustment for Western diet for the remainder of intake. Our study is unique in finding that associations between consuming a Western diet outside the fast food restaurant and poor dietary outcomes were stronger than associations between fast food and poor diet.

**TABLE 4**

Independent associations of fast food consumption and dietary pattern for the remainder of diet with weight status and total dietary intake among US children<sup>1</sup>

	Low fast food consumption <sup>2</sup>	High fast food consumption	Western dietary pattern <sup>3</sup>
Overweight/obese (%)			
Model 1 (including fast food only) <sup>4</sup>	-2.3 (-6.4, 1.9) <sup>5</sup>	6.7 (0.2, 13.2)	—
Model 2 (including fast food and dietary pattern) <sup>6</sup>	-2.8 (-6.8, 1.1)	5.6 (-0.9, 12.1)	5.9 (1.3, 10.5)*
Food groups (kcal/d)			
Milk			
Model 1 (including fast food only)	-21 (-34, -8)	-65 (-85, -45)	—
Model 2 (including fast food and dietary pattern)	-13 (-25, 0)	-49 (-68, -30)	-95 (-105, -84)***
Fruit			
Model 1 (including fast food only)	-5 (-11, 2)	-19 (-26, -12)	—
Model 2 (including fast food and dietary pattern)	-1 (-8, 6)	-12 (-20, -5)	-39 (-46, -32)***
Vegetables <sup>7</sup>			
Model 1 (including fast food only)	-2 (-5, 1)	-4 (-9, 0)	—
Model 2 (including fast food and dietary pattern)	-1 (-4, 1)	-3 (-8, 1)	-7 (-10, -5)*
SSBs <sup>8</sup>			
Model 1 (including fast food only)	21 (10, 33)	54 (32, 76)	—
Model 2 (including fast food and dietary pattern)	13 (1, 24)	37 (17, 58)	98 (86, 110)***
French fries			
Model 1 (including fast food only)	38 (31, 46)	80 (66, 94)	—
Model 2 (including fast food and dietary pattern)	37 (30, 45)	78 (64, 91)	13 (4, 22)***
Nutrients			
Total energy (kcal/d)			
Model 1 (including fast food only)	199 (135, 264)	82 (4, 160)	—
Model 2 (including fast food and dietary pattern)	188 (123, 252)	63 (-15, 140)	110 (55, 166)
Fat (% kcal)			
Model 1 (including fast food only)	0.5 (-0.2, 1.2)	2.1 (1.2, 3.0)	—
Model 2 (including fast food and dietary pattern)	0.3 (-0.4, 1.1)	1.8 (0.8, 2.7)	1.9 (1.2, 2.6)*
Fiber (g/1000 kcal)			
Model 1 (including fast food only)	-0.4 (-0.7, 0.0)	-1.2 (-1.5, -0.8)	—
Model 2 (including fast food and dietary pattern)	-0.2 (-0.6, 0.1)	-0.9 (-1.2, -0.5)	-1.7 (-2.0, -1.5)***
Calcium (mg/1000 kcal)			
Model 1 (including fast food only)	-33 (-55, -11)	-74 (-109, -40)	—
Model 2 (including fast food and dietary pattern)	-20 (-41, 1)	-50 (-83, -17)	-144 (-162, -126)***

<sup>1</sup>Data are for 4466 children aged 2–18 y from NHANES 2007–2010. All results account for complex survey design and are weighted to be nationally representative. Each outcome was included as the dependent variable in a separate logistic (overweight/obesity) or linear (dietary outcomes) regression model with fast food consumption (dummy variables for low and high consumption) as the independent variable. \*Association with a Western dietary pattern was significantly different from association with low fast food consumption; \*\*association with a Western dietary pattern was significantly different from association with high fast food consumption ( $P < 0.05$ , Wald test). All models were adjusted for age (age, age<sup>2</sup>), sex, race-ethnicity (non-Hispanic white, non-Hispanic black, Mexican American, or other race/ethnicity), income (household income  $\leq 130\%$ , 131–185%, 186–350%, or  $>350\%$  of the Federal Poverty Level), parental education ( $<$ high school, high school, some college, or college degree), 2-d mean total energy intake (age-group specific quintiles), and weight status (nonoverweight/obese, overweight, or obese) where appropriate.

<sup>2</sup>Fast food consumption is defined by the 2-d mean percentage of total energy intake from fast food restaurants: nonconsumers, 0% kcal from fast food; low-consumers, 0.1–30% kcal from fast food; high-consumers,  $>30\%$  kcal from fast food.

<sup>3</sup>Dietary patterns for the remainder of intake outside the fast food restaurant were determined by cluster analysis by using standardized  $z$  scores for the percentage of non-fast food energy intake from each food group.

<sup>4</sup>Model includes fast food consumption as independent variable; associations of outcomes with fast food are unadjusted for dietary pattern.

<sup>5</sup> $\beta$ ; 95% CI in parentheses (all such values). Coefficients from logistic models were transformed into differences in prevalence of outcome (overweight/obesity) by exposure.

<sup>6</sup>Model includes fast food consumption and dietary pattern as independent variables; associations of outcomes with fast food are adjusted for dietary pattern for the remainder of diet, and associations of outcomes with dietary pattern for the remainder of diet are adjusted for fast food intake.

<sup>7</sup>Includes fresh, frozen, or canned nonstarchy vegetables.

<sup>8</sup>SSB, sugar-sweetened beverage: includes sodas, fruit drinks, sports drinks, and energy drinks.

Studies linking fast food intake and obesity rarely consider heterogeneity between fast food consumers and nonconsumers. Prospective studies that used between-subjects analyses acknowledge that positive associations between fast food frequency and weight gain may result from the poor nutritional quality of fast food or from other unmeasured behaviors associated with fast food intake and with weight gain (26, 27). Indeed, use of a within-person approach to control for unobserved heterogeneity, Niemeier et al (26) found that change in quick-service food intake was not associated with weight gain. In agreement, we found that high fast food consumption was not associated with overweight/obesity after adjustment for heterogeneity represented by the dietary pattern for the remainder of intake. Moreover, we extended these results by finding that a Western dietary pattern remained significantly associated with overweight/obesity after controlling for fast food consumption.

In our study, associations between high fast food intake and overweight/obesity or poor dietary outcomes were overestimated by  $\geq 10\%$  without adjustment for dietary pattern of the remaining diet, consistent with previous work among adults finding overestimation by 25% (28). Our findings suggest that the effect of public health efforts targeted at fast food restaurants may also be overestimated, such that these efforts may be necessary but not sufficient to reduce childhood obesity if the remainder of the diet is not also addressed (17). For example, the effect of fast food menu board nutrition labeling on children's total energy intake is not clear (52–55).

To identify dietary factors associated with obesity, our findings suggest that the location where foods are obtained may not be as important as the nutritional quality of foods consumed. We provide evidence that a Western dietary pattern outside the fast food restaurant, although mostly obtained from grocery stores (7), was associated with overweight/obesity, whereas fast food was not. In agreement, scholars note that supermarkets, which provide fresh produce but also SSBs and chips, can contribute to both healthy and less healthy purchasing patterns; for example, foods consumed by US children from retail food stores were found similar to fast foods in total solid fat and added sugar content (12, 56–58). On the other hand, healthier fast food items are available; however, very few individuals currently select these options (59, 60). We similarly found that milk, fruit, and vegetables made very minor contributions to children's fast food intake, and we did not observe a cluster of children consuming only more healthful fast foods.

A main limitation of this study was the use of self-reported dietary intake, because foods perceived as unhealthy may be selectively underreported, and misreporting may be associated with age and obesity (61–63). Validation studies that use direct observation provide evidence that children misreport meals consumed from schools on 24-h recalls, but similar study designs are needed to determine whether children selectively underreport fast foods and if fast food consumers are more likely to underreport compared with fast food nonconsumers (64, 65). To minimize the influence of dietary measurement error, we used energy-adjusted intakes (66). In addition, results were robust to alternate classification of fast food consumption by weekly frequency. Nonetheless, potential misclassification of dietary behaviors is still possible, because misreporting might be characteristic of individuals regardless of dietary assessment method, and the use of only 2 recalls may result in excess of

nonconsumption for episodically consumed foods (49, 50, 67). Although estimates did not change with additional adjustment for physical activity, residual confounding is possible. Finally, the cross-sectional study design prevents causal interpretation.

The strengths of this analysis included the use of a large nationally representative sample and current data. Dietary recalls differentiated all items by purchase location, uniquely enabling us to separate fast foods from the remainder of diet. Classifying fast food intake by its contribution to energy intake is advantageous over frequency measures that disregard amount consumed (18).

In conclusion, our study suggests that fast food consumers may have less healthy dietary patterns outside the fast food restaurant. We provide evidence that a Western dietary pattern for the remainder of intake may be more strongly associated with overweight/obesity than fast food consumption itself. Our results support the need to confirm this hypothesis in randomized trials, which could compare the effects among fast food consumers of dietary intervention arms altering only fast food intake compared with altering both fast food and non-fast food intakes.

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