RESEARCH
Original Research

Fast-Food Offerings in the United States in 1986, 1991, and 2016 Show Large Increases in Food Variety, Portion Size, Dietary Energy, and Selected Micronutrients

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ABSTRACT

Background US national survey data shows fast food accounted for 11% of daily caloric intake in 2007-2010.

Objective To provide a detailed assessment of changes over time in fast-food menu offerings over 30 years, including food variety (number of items as a proxy), portion size, energy, energy density, and selected micronutrients (sodium, calcium, and iron as percent daily value [%DV]), and to compare changes over time across menu categories (entrées, sides, and desserts).

Design Fast-food entrées, sides, and dessert menu item data for 1986, 1991, and 2016 were compiled from primary and secondary sources for 10 popular fast-food restaurants.

Statistical Analysis Descriptive statistics were calculated. Linear mixed-effects analysis of variance was performed to examine changes over time by menu category.

Results From 1986 to 2016, the number of entrées, sides, and desserts for all restaurants combined increased by 226%. Portion sizes of entrées (13 g/decade) and desserts (24 g/decade), but not sides, increased significantly, and the energy (kilocalories) and sodium of items in all three menu categories increased significantly. Desserts showed the largest increase in energy (62 kcal/decade), and entrées had the largest increase in sodium (4.6% DV/decade). Calcium increased significantly in entrées (1.2%DV/decade) and to a greater extent in desserts (3.9% DV/decade), but not sides, and iron increased significantly only in desserts (1.4% DV/decade).

Conclusions These results demonstrate broadly detrimental changes in fast-food restaurant offerings over a 30-year span including increasing variety, portion size, energy, and sodium content. Research is needed to identify effective strategies that may help consumers reduce energy intake from fast-food restaurants as part of measures to improve dietary-related health issues in the United States.
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APPROXIMATELY 40% OF US ADULTS AGED 20 TO 74 years are obese, up from around 13% in 1960-1962 and 23% in 1988-1994.[1] In turn, obesity is the second leading risk factor for disability and the fourth leading risk factor for mortality in the United States.[2] Fast food, defined as "easily prepared processed food served in snack bars and restaurants as a quick meal or to be taken away,"[3] has been positively associated with adiposity and daily caloric intake.[4,5] It has also been observed that for each additional meal eaten outside of the home, adult Americans are likely to increase calorie intake by about 100 to 200 kcal/day.[6,7] An integral part of the average American diet, fast food accounted for 4% of total caloric intake in 1977-1978,[8] and in 2007-2010, it made up 11% of daily total caloric intake.[4] Restaurant foods tend to have large portion sizes as well as high energy density,[9,10] two factors that have been causally associated with higher energy intake.[11–14] Furthermore, several observational studies have shown that frequency of eating away from home is positively associated with a higher body mass index (BMI; kilograms per square meter) and increased risk for chronic health conditions like hypertension, obesity, and insulin resistance.[9,15,16]

Cross-sectional studies show that fast-food consumption is associated with a diet higher in sodium,[6,17] and although controversial, excess sodium intake has been linked with hypertension in prospective studies and randomized clinical trials.[18] With the exception of sodium, there has been relatively little attention paid to the micronutrient content of fast foods. However, away from home eating has been associated with lower serum concentrations of essential micronutrients in American adults,[19] with fast-food consumption specifically related to a diet low in micronutrient density.[20,21] Although between 1971-1974 and 1999-2000, data from the National Health and Nutrition Examination Surveys indicated an increase in mean intake of iron,[22] many women aged 19 to 50 years do not receive enough iron. The prevalence of iron deficiency in US women of childbearing age is estimated at 10.4% for nonpregnant and 16.3% for pregnant women, with greater prevalences among non-Hispanic black, Mexican American, or women of "other" race or ethnicities than white women.[23] In addition, Americans do not consume adequate amounts of calcium compared with the recommendation.[24] The prevalence of low bone mass in US adults>age 50 years is 43.9% and of osteoporosis is 10.3%.[25] There is strong evidence that low calcium intake throughout life, but particularly during childhood and adolescence, contributes to the development of osteoporosis and is one of several dietary factors that plays a role in bone health.[26] Osteoporosis increases the risk of bone fracture, especially hip fracture, which can lead to death due to pneumonia-associated immobility.[27]

Previous studies have shown an increase in portion size and portions consumed from fast-food items over time coincident with the obesity epidemic.[28,29] Apart from portion size, reports on changes over time in fast-food menu item nutritional composition have been studied as far back as 1996 and up to 2016 but in separate reports.[30–40] Although previous studies show both energy and portion size have increased, none have included an assessment of energy density, a dietary factor that promotes energy intake[41] and is suggested to be important for weight control.[42,43] In addition, no studies have reported on changes in calcium or iron. Moreover, most previous reports have either studied a small number of restaurants or restricted evaluations to a small subset of restaurant food offerings and nutrients of interest. Therefore, there is a need for more comprehensive as well as a more recent analysis of changes in a wide variety of dietary variables.

The purpose of this study was twofold: (1) to provide a detailed description of changes over time in portion size, energy, energy density, and selected micronutrients of public health interest (sodium, calcium, and iron) in food items of 10 of the major US fast-food restaurants based on sales[44] in 1986, 1991, and 2016 and (2) to examine these changes by menu category (entrées, sides, and desserts). The hypothesis was that over time, portion size, energy, energy density, and sodium have increased while calcium and iron decreased in each menu category over time.

RESEARCH SNAPSHOT

Research Question: How did the portion size, energy, and micronutrients for fast foods in US restaurants from 1986 to 2016 change over time overall and when grouped by menu category and restaurant?

Key Findings: This study is an analysis of changes in portion size, energy, energy density, and selected micronutrients among 1,787 menu items from 10 fast-food restaurants. Data were retrieved from the 1986 and 1991 versions of *The Fast Food Guide* and online sources in 2016. Over the 30-year period, there was a large mean increase in the number of entrées, sides, and desserts of 22.9 per year, and energy increases in desserts were particularly high. Entrées increased significantly in portion size (13 g/decade), energy (30 kcal/decade), sodium (4.6 %DV/decade), and calcium (1.2 %DV/decade). Desserts increased significantly in portion size (24 g/decade), energy (62 kcal/decade), sodium (1.2 %DV/decade), calcium (3.9 %DV/decade), and iron (1.4 %DV/decade). Sides also showed a significant increase in energy (14 kcal/decade) and sodium (3.9 %DV/decade).

METHODS

Data Collection

Data from 10 fast-food restaurants presented in the 1986 and 1991 versions of *The Fast Food Guide*[45,46] and online through primary (the restaurant website) or secondary[47,48] websites for 2016 data were used. For about 30 menu items, 2017 websites were used. *The Fast Food Guide* provides information on the energy and nutrient content of fast-food menu items, health effects of fast-food consumption, and guidance on making educated choices for consumers who choose to eat fast food. For any energy or nutrient data that were missing from the primary website, data from a secondary website were used if available. The 10 restaurants were Arby's, Burger King, Carl's Jr, Dairy Queen, Hardee's, Jack in the Box, KFC, Long John Silver's, McDonald's, and Wendy's. These restaurants were chosen because the nutritional information on the key nutritional variables of portion size, energy, and sodium were available for each of the three years being analyzed. These 10 restaurants were in the QSR50, the top 50 quick service and fast casual restaurants for US sales in 2014, and nine of the 10 were in the top 20.[44] Fast-food restaurants excluded that were in the top 20 for sales in either 1986, 1991, or 2016 were (in alphabetical order) Big Boy, Chick-fil-A, Church's, Domino's Pizza, Little Caesars, Papa John's, Pizza Hut, Popeyes Famous Fried Chicken, Roy Rogers, Sonic Drive-In, Taco Bell.[44–46] To be included in the analysis, restaurants were required to have at least three food items for each dietary variable examined (eg, portion size) per menu category (entrées, sides, and desserts) for at least two of the analytical years (1986, 1991, and 2016). Restaurants not meeting these requirements were excluded from analysis of energy and nutrients by menu category and analytical year. In addition, calcium and iron data in all three analytical years were available from only four of the 10 restaurants (Arby's, Dairy Queen, McDonald's, and Wendy's). Individual foods with no data available for the nutritional variables available were not used in the analysis of energy and nutrients (<1% of entrées, sides, and desserts across the 10 restaurants). For the analysis of the number of food items available as entrées, sides, or desserts, food items were included regardless if the nutritional information was available. For food items with multiple item sizes (eg, french fries), all available sizes were included in each year for the reasons that the number of items could have changed over time (eg, one item in 1 year, two or more items in another year) and their portion sizes could also have changed over time but not proportionately for each size item. Beverages (except for items listed as milkshakes, shakes, or malts), condiments, and multicomponent dinners or platters were excluded for the following reasons. All beverages were excluded because not all restaurants specified beverage sizes and data were not available for each analytical year. Condiments were also excluded because data were available for only two of the analytical years from four of the restaurants. All multicomponent dinners or platters and combo meals were excluded because these were not on the menus of any of the 10 restaurants in this analysis in 1986 and were only on menus for 1991 and 2016 in some of the restaurants.

Food Categorizing System

Foods from each restaurant were categorized broadly by food type (eg, sandwich, salads, fries) and place listed on the menu for 2016, based on details derived from its restaurant-specific name. For example, Arby's Bac'n Cheddar Deluxe Roast Beef Sandwich was categorized as a "sandwich," and seasoned curly fries from Jack in the Box were categorized as "fries." This categorization allowed for grouping of similar foods by menu category—entrées, sides, or desserts—based on guidance by headers for each online restaurant menu. Note that in some cases it was possible for the same type of food (eg, pasta) to be listed as both an entrée and a side dish, even at the same restaurant. In this case the entrée would typically be larger than the side. There were not enough breakfast items in all restaurants for all years to examine separately, so these were assigned to entrées or sides as appropriate. Because *The Fast Food Guide* sources did not have foods categorized by menu item and instead were alphabetized, whichever menu category applied to certain types of foods for a certain restaurant online in 2016 was typically applied to the same type of foods in 1986 and 1991. For example, in 2016, the Arby's Super Roast Beef Sandwich was listed as a part of "entrées" and its food type was sandwich. Therefore, the Arby's Bac'n Cheddar Deluxe Roast Beef in 1986 was classified as an entrée because it was also a sandwich from Arby's. Figure 1 shows the broad food types assigned to entrées, sides, and desserts menu categories.

Calculations and Statistical Analysis

Energy density was computed in kilocalories per gram from the portion size (grams) and energy (kilocalories) data. In addition, sodium, calcium, and iron data were all converted to percent daily value (%DV) to allow for comparisons across years because in *The Fast Food Guides*,[45,46] sodium data were given in milligrams, and calcium and iron were given as percent US recommended daily allowance (RDA), but in 2016, data for each of these were given as %DV. For sodium, across all analytical years %DV sodium in food=(milligrams sodium/2,400 mg)*100%, where 2,400 mg was the daily value for sodium in 2016[49,50] and there was no daily value for sodium in 1986 or 1991.[50] For calcium and iron, because the US RDA and daily value were the same across all analytical years (1,000 mg for calcium and 18 mg for iron[49,50]), no conversion was needed and all are expressed as %DV in 2016. In addition, milligrams calcium and milligrams iron in the menu items were derived from the percent US RDA and %DV values using the following formulae. For calcium: % US RDA (or %DV) calcium$\times$1,000 mg=milligrams calcium in food; for iron: % US RDA (or %DV) iron$\times$18 mg=milligrams iron in food. Sodium, calcium, and iron values were also expressed as density in milligrams per gram and %DV per 100 kcal.

SPSS[51] and R, version 3.4.3,[52] were used for basic analyses. In addition, the lme4 package,[53] an addition to the R base code, was used for all linear mixed-effects (LME) modeling. A significance level of α=.05 was used throughout. When multiple analyses with related subsets of the data set were conducted, a Bonferroni adjustment is provided. To analyze the changes over time in fast foods across the 10 restaurants being considered, descriptive statistics were computed for the number of food items, portion size (grams), energy (kilocalories), energy density (kilocalories per gram), sodium (%DV), calcium (%DV), and iron (%DV). The energy and nutrient data were generally not normally distributed, but due to the number of data points available, the non-normal distribution was considered to have little impact on the results. Therefore, the mean, standard deviation, 25th and 75th percentiles were used to summarize the data.

To examine changes over the 30-year time window, LME models were computed. LME models allow for the assessment of linear trends that may vary slightly based on nesting in the data. In this context, there are two crossed levels of nesting: observations nested within restaurants and observations nested within the same food types (a nesting that is more coarse than nesting by menu item name, but more refined than nesting by one of three meal components; see Figure 1). Nesting at the food type was well justified (as

Menu category	Food types
Entrées	Breakfast items (burritos and sandwiches), burgers, cereal, chicken, eggs, hot dogs, pasta, pastries, potato bowls, salads, sandwiches, seafood, soup, tacos and burritos and wraps and quesadillas
Sides	Beans, breads and rolls and biscuits, cheeses (cottage, curds), chips, eggs (side menu), french fries, fried snacks (other than french fries), fruit, meat (side menu), pasta and rice (side menu), potato (other than french fries), salad (side menu), sandwich (side menu), soup (side menu), tacos and burritos and wraps and quesadillas, vegetables, yogurt
Desserts	Brownie, cakes, cookies, fruit, ice cream and frozen yogurt, milkshake and shake and malt, pastries, pies, pudding

Figure 1. Food types assigned to the different fast food menu item categories for analysis of energy and nutrient content in 1986, 1991, and 2016. Meals and combo meals not included, beverages not included, breakfast items integrated into entrées, sides, desserts. "Side menu" indicates foods listed as side items on menus. Note in some cases it was possible for the same type of food to be listed as both an entrée and a dessert (eg, pastries) or side dish (eg, pasta). In the latter case, the entrée would typically be larger than the side dish.

inclusion of the random intercept for different food types was statistically significant for all of the dependent variables under study [$P<0.001$]). The same was nearly observed for the nesting observed at the restaurant level (all but three $P\leq0.001$). Consequently, the restaurant random intercept was included in all subsequent models.

To further assist in understanding the variability in the data, the menu items were more broadly grouped into three distinct meal components—entrées, sides, and desserts—as described previously. To examine the usefulness of the LME models, multiple regression models were computed adding the meal component, then the time variable, and then the interaction of the meal component and time (thus allowing for different slopes for time for each of the different meal components). For all dependent variables, at least one of the time, slope, or the interaction between meal component and time was statistically significant. This suggests that for all of the dependent variables, at least one of the meal components significantly changed over time. Instead of presenting the multiple regression models with time, meal component, and interaction term (which would require adding multiple parameters to estimate slope effects for different components), dependent variable models are presented for each meal component separately, because this allows for an easier assessment of the statistical significance of the time effect for each variable.

Lastly, to check for possible differences in annual change in energy and nutrients between items that were identified as consistent across all three time points vs those that were added or removed at various time points, an additional LME model was performed. Food items were dummy coded as consistent across all three time points or not (1 for yes and 0 otherwise) based on the menu item name. This consistency variable was added to the model in which year and the interaction were fixed effects, and random effects for the intercept and year were included for the type of food classification, and a random effect for intercept was included for restaurant. A significant interaction effect indicated the annual change was different for the consistently labeled items in comparison with the annual change for all other items.

This study is exempt from institutional review board approval given that it is not human subjects research.

RESULTS

Changes in Number of Food Items Overall and by Menu Category

Across the 10 fast-food restaurants, the number of items available per year as entrées, sides, and desserts increased substantially (Figure 2). Overall, the number of food items in these categories combined increased by 62% in the 5-year period between 1986 and 1991, with the number of desserts more than doubling and the number of entrées and sides increasing by 51% and 40%, respectively. Over the next 25 years, there was continuing growth in the number of food items but the rate of change was slower, with the number of entrées and desserts more than doubling (121% and 111% increase, respectively), and the number of sides increasing by 45%. Over the 30-year period, there was a 226% increase in the number of entrées, sides, and desserts combined, representing a mean increase per year of 22.9 food items. The restaurant with the lowest relative increase in menu items was Wendy's (increasing by 89% over the 30-year period), that with the lowest increase in items per year was Long John Silver's (increasing by 0.6 food items per year), and that with the most extreme increase was Dairy Queen (increasing by 391% over the 30-year period, representing 5.6 additional food items per year).

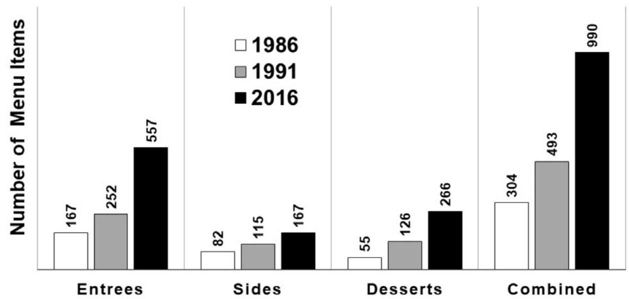

Figure 2. Number of fast-food menu items per analytical year available as entrées, sides, and desserts, and the three types combined.

Changes in Portion Size, Energy, and Energy Density by Menu Category

Descriptive statistics including mean, standard deviation, and 25th and 75th percentiles for portion size, energy, and energy density at each time point by menu category are shown in Table 1. Portion sizes (Figure 3A) of entrées and desserts increased significantly over time, 1.3 and 2.4 grams/year on average (13 and 24 g/decade, respectively). The portion size of sides did not change significantly over time. On the other hand, the energy per item of all three menu categories increased significantly over time (Figure 3B), with desserts showing the largest increase, on average (62 kcal/decade), and entrées showing the next largest increase (30 kcal/decade). Energy density changes over time (Figure 3C) showed a small but significant decrease for entrées (−0.03 kcal/g/decade), no significant change for sides, and a small but significant increase for desserts (0.06 kcal/g/decade).

Changes in Sodium, Calcium, and Iron by Menu Category

Sodium, calcium, and iron expressed as %DV are described in Table 2 and Figure 4A-C. The actual and predicted means, predicted trend line, and spread of the individual data points for these micronutrients are shown in Figure 4(A-C). There were significant increases over time in sodium (%DV) for all three menu categories, with entrées having the most marked average increase (4.6 %DV/decade), followed by sides (3.9 %DV/decade). Desserts showed a smaller average increase in sodium (1.2 %DV/decade). The significant increase in sodium in entrées and sides remained even when the increase was normalized for energy (4.6 %DV/100 kcal in entrées, 3.9 %DV/100 kcal in sides) or portion size, with the exception of desserts (data not shown). Calcium increased significantly in entrées (1.2 %DV/decade) and to a greater extent in desserts (3.9 %DV/decade), with no significant change in sides. Calcium density (%DV/100 kcal) also increased significantly in sides (1.1 %DV/100 kcal/decade) but not in entrées or desserts (data not shown). Iron increased significantly in desserts (1.4 %DV/decade), although there were no significant changes in entrées and sides. When normalized for energy (%DV/100 kcal), iron decreased significantly in entrées (−0.4 %DV/100

Table 1. Portion size, energy, and energy density in menu items from fast-food restaurants in 1986, 1991, and 2016[a]

	Entrées			Sides			Desserts		
	n	*Mean±SD*[b]	*Q_1, Q_3*[c]	*n*	*Mean±SD*	*Q_1, Q_3*	*n*	*Mean±SD*	*Q_1, Q_3*
Portion size (g)									
1986	142	167±74	116, 204	70	138±119	68, 139	53	217±127	113, 291
1991	242	177±82	121, 218	115	148±106	76, 231	124	195±119	99, 307
2016	544	208±94	136, 266	162	127±67	85, 150	249	298±175	153, 418
Energy (kcal)									
1986	161	430±165	318, 521	78	238±150	137, 306	55	392±181	295, 435
1991	252	395±171	285, 500	115	251±180	98, 385	126	341±159	230, 448
2016	556	480±212	330, 600	167	287±185	150, 410	266	572±294	330, 750
Energy density (kcal/g)									
1986	142	2.69±0.55	2.43, 2.97	70	2.28±1.25	1.27, 3.24	53	2.16±1.02	1.52, 2.47
1991	242	2.45±0.83	2.19, 2.89	115	2.08±1.33	0.86, 3.23	124	2.15±1.09	1.34, 2.81
2016	543	2.43±0.66	2.11, 2.87	162	2.35±1.12	1.21, 3.14	249	2.25±0.97	1.61, 2.35

[a]Menu food category types entrées, sides, and desserts from 10 restaurants: Arby's, Burger King, Carl's Jr, Dairy Queen, Hardee's, Jack in the Box, KFC, Long John Silver's, McDonald's, and Wendy's. Information on portion size, energy, and energy density values were not available for all foods in all analytical years, thus sample sizes may differ within the same analytical year across these outcomes.
[b]SD=standard deviation.
[c]Q_1, Q_3=indicates the interquartile range, which are the 25th and 75th percentiles, respectively.

kcal/decade) and increased significantly in desserts (0.2 %DV/100 kcal/decade).

Changes in Items That Remained vs Did Not Remain on the Menus at All Three Time Points

Analysis of the differences in changes over time in energy and nutrient contents of items that remained on the menus in all three analytical years (n=57) compared with other items showed significant differences in some nutritional variables for entrées but not for sides or desserts. Specifically, entrée portion size, energy, and sodium for items that remained on the menu in all 3 analytical years showed significantly *smaller increases* over time compared with other items (portion size Δ=13.6 g/decade less, P=0.004; energy Δ=37.9 kcal/decade less, P<0.001; and sodium Δ=5.1%DV/decade less, P<0.001).

DISCUSSION

This article describes changes in portion size, number of restaurant offerings, energy content, energy density, and sodium of entrées, sides, and desserts from 10 major fast-food restaurants over the past 30 years, the longest period of time published to date. Iron and calcium from four restaurants, two micronutrients of importance for public health for which changes in fast food have not previously been reported, are also included. The major findings were that there were large mean increases in energy and sodium for entrées, sides, and desserts and in portion size for entrées and desserts from 1986 to 2016. Furthermore, there were substantial increases in the number of foods across and within menu categories, indicating a greater variety of food choices available, and the additional choices were not all healthy, as evidenced by the increased distribution of data toward higher values over time for portion size and energy of entrées and desserts, and sodium for all three menu categories. Combined, these results indicate a broader range of unhealthy changes in fast-food offerings than previously indicated.

The 30-year increase in portion size among entrées and desserts in the present study is consistent with previous reports over different periods of time or for a smaller number of food items.[29,54] The marked increases observed in the energy content of entrées and desserts is consistent with the previous 14-year study that examined menu item changes from 1997-1998 to 2009-2010,[30] but most studies conducted on a more limited number of foods and restaurants did not identify this trend.[32,36,39] In addition, the 226% increase in the number of foods (a surrogate for variety) among entrées, sides, and desserts is particularly noteworthy and is consistent with previous studies over shorter periods of time and fewer restaurant chains which reported 53%[30] and 18%,[35] and more broadly trends for increasing dietary variety in the US food supply.[55] A larger portion size and greater variety of foods, particularly of energy-dense foods, are two of the key factors strongly suspected of contributing to the obesity epidemic[56,57] because both increased portion sizes and increased variety result in an increase in energy intake acutely, which may not be fully compensated at other eating occasions.[56,58]

Dietary sodium is also a nutrient of great public health interest, and in the present analysis, sodium increased among all three menu categories, but with the greatest increases seen in entrées and side dishes. These increases were beyond those expected due to the increases in portion size or energy, as indicated by the increases in sodium density values, with the exception of desserts in which the increase in sodium over time was proportional to the portion size increase. These results are in agreement with studies on changes in sodium in fast food from 2005 to 2011[34] and 1997-1998 to 2009-2010

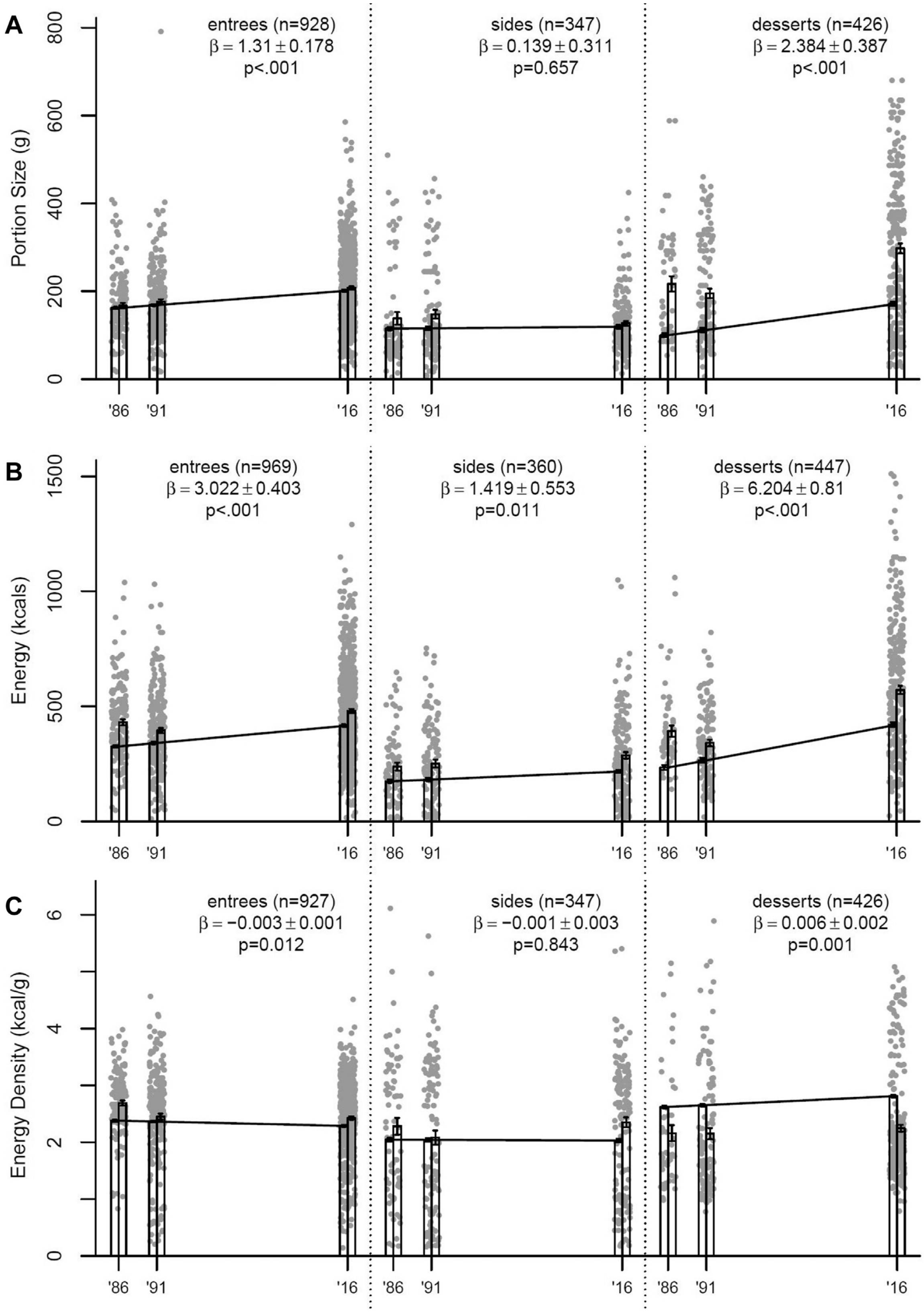

Figure 3. (A-C) Actual changes and linear mixed model-estimated changes in fast-food portion size (A), energy (B), and energy density (C) by menu category and analytical year. Each pair of bars shows the actual mean±standard error (SE) on the right bar and model estimated mean±SE on the left bar. Gray dots represent data points in each analytical year. *P* values are shown on each graph, but significance is established at α=.05/3=.017 (Bonferroni adjustment).

Table 2. Sodium, calcium, and iron in menu items from fast-food restaurants by menu category in 1986, 1991, and 2016[a]

	Entrées			Sides			Desserts		
	n	*Mean±SD*[b]	*Q_1, Q_3*[c]	*n*	*Mean±SD*	*Q_1, Q_3*	*n*	*Mean±SD*	*Q_1, Q_3*
Sodium (%DV[d])									
1986	161	35.9±14.9	26.3, 44.5	76	14.1±11.3	5.6, 19.0	55	9.3±4.1	6.1, 11.5
1991	252	34.5±15.3	25.0, 44.2	115	17.2±17.4	4.7, 25.7	126	8.7±4.6	4.3, 11.9
2016	556	47.2±21.0	32.1, 58.9	167	25.7±20.7	10.6, 35.0	266	12.3±6.6	7.9, 15.8
Calcium (%DV)									
1986	152	13.2±8.3	8.0, 20.0	70	6.2±9.2	1.0, 8.0	52	22.4±17.2	10.0, 32.0
1991	238	14.0±11.0	6.0, 20.0	113	5.2±8.3	0.0, 8.0	126	19.8±15.8	5.3, 31.5
2016	205	14.4±10.1	6.0, 20.0	74	8.6±16.8	2.0, 10.0	166	38.7±19.4	25, 50
Iron (%DV)									
1986	152	18.0±10.2	11.0, 25.0	72	7.8±6.5	3.1, 14.3	52	6.8±5.8	2.8, 8.3
1991	238	17.6±11.0	10.0, 20.0	113	8.0±7.5	4.0, 10.0	125	5.3±4.8	2.0, 8.0
2016	205	15.6±8.2	10.0, 20.0	74	6.3±5.6	2.0, 8.0	166	11.4±6.9	8.0, 15.0

[a]The n differs across nutrients because sodium information was available from 10 restaurants (Arby's, Burger King, Carl's Jr, Dairy Queen, Hardee's, Jack in the Box, KFC, Long John Silver's, McDonald's, and Wendy's) and calcium and iron were available from four restaurants (Arby's, Dairy Queen, McDonald's, and Wendy's).
[b]SD=standard deviation.
[c]Q_1, Q_3 indicates the interquartile range, which are the 25th and 75th percentiles, respectively.
[d]%DV=percent daily value.

for entrées but not sides.[37] However, they are not in agreement with studies that reported on a limited number of foods[38,39] or over a shorter period of time.[32,40] Over 80% of Americans consume sodium at or above the recommendation level.[24] Because excess sodium has been linked to hypertension, a major risk factor of stroke and cardiovascular disease,[59] reducing instead of increasing sodium in fast-food restaurants could potentially impact the incidence of these fatal diseases. The US food industry has recently made progress in voluntarily reducing sodium as recommended by the Food and Drug Administration, and the results of this analysis suggest that national health could possibly improve if fast-food restaurants follow suit.[60]

Calcium showed the greatest increases in desserts followed by entrées, and iron showed the greatest increases in desserts, all of which were statistically significant. It was expected that both calcium and iron would decrease over time, thus the observed changes were inconsistent with our hypotheses. Calcium's increase in foods overall could have been heavily influenced by Dairy Queen, which contributed a large number of dairy-based desserts. However, although certain populations of Americans struggle to get enough iron and calcium,[23,25] fast food should not be the primary source of these micronutrients because fast food also tends to be high in calories and added sugars.[33,35] Increases in type 2 diabetes, for which excess added sugar consumption may be a major risk factor,[61] have been associated with higher obesity rates in the United States,[62] and adults with obesity tend to consume a diet less rich in micronutrients than their leaner counterparts.[63]

The entrée items that remained on the menu on all three analytical years showed smaller increases over time for portion size, energy, and sodium than for other entrée items that were newly introduced or discontinued, suggesting that changes in the nutritional value of the menu offerings as a whole were unhealthful, despite the fact that some restaurants may have offered a selection of more healthful items in recent years.[36,64,65] However, the offering of at least some healthful items on fast-food restaurant menus is a welcome change that should be supported and may in part be due to the implementation of the Affordable Care Act (ACA), which includes federal menu labeling legislation. [66]A recent analysis[67] that compared the energy content of large chain restaurant menu items in common in 2008 (before passage of the ACA) and also in 2012-2015 (after the passage of the ACA) showed an overall slight reduction in mean energy in 2015 vs 2008, suggesting that at least some menu items may have been reformulated to be lower in calories, either through a reduction in portion size or change in macronutrient distribution, and is supported by some[31,36,68] but not all[69] other studies with comparisons before and after menu labeling. Bleich and colleagues also found that mean calories among newly introduced menu items decreased from 2012 to 2014,[64,65] although not significantly, so when 2015 was included,[67] these decreases were largely influenced by new entrée and menu items not core to the business in chains with a specific focus (eg, burgers or pizza). The present study was not able to account for changes due to the ACA because of the 25-year gap in data from 1991 to 2016. Despite some positive changes in recent years, fast-food menus remain unhealthful overall, especially when one considers our analysis was on à la carte items. If a meal includes one entrée and one side, using the mean values of these in 2016 (from Table 1), the meal would total 767 kcal, or 38.5% of a 2,000-kcal diet. Using the 75th percentile values, the meal would total 1,010 kcal, or 50.5% of a 2,000-kcal diet. These meal

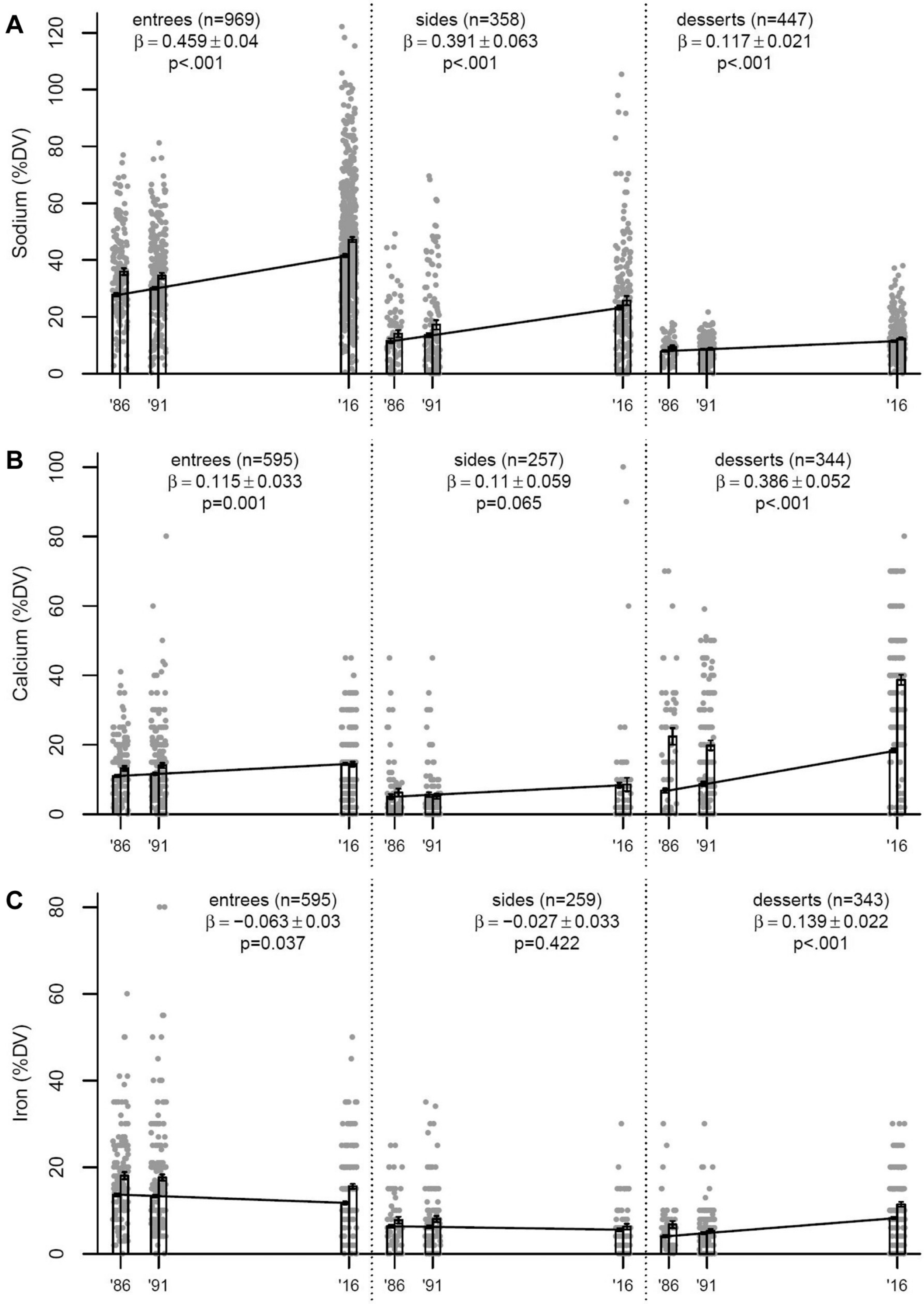

Figure 4. (A-C). Actual changes and linear mixed model-estimated changes in fast-food sodium (A), calcium (B), and iron (C) by menu category and analytical year. Each pair of bars shows the actual mean±standard error (SE) on the right bar and model estimated mean±SE on the left bar. Gray dots represent data points in each analytical year. *P* values are shown on each graph, but significance is established at α=.05/3=.017 (Bonferroni adjustment). %DV=percent daily value.

examples are likely underestimates because they do not include estimates for beverage or dessert items.

The present study has both strengths and weaknesses. It is an analysis of a broader set of dietary factors in fast-food restaurants and is a model for other studies to continue to track changes in fast foods. The study was also an aggregate of multiple restaurants, multiple variables of nutritional composition, and multiple menu categories and included breakfast items and desserts, which are frequently overlooked. However, in some cases the categorization of foods to menu categories was subjective. In addition, the conclusions for calcium and iron were made based on four of the 10 restaurants, respectively, because those data were not available for the other restaurants. Another limitation is that although combo meals and multicomponent meals or platters are commonly consumed, these were excluded from analysis because they were not present on the menus in 1986 and were only in select restaurants in 1991 and 2016. Likewise, the present analysis only takes into account individual à la carte items as they were presented on the menu, and does not account for the combinations in which people order or consume them. Finally, the analysis did not take into account the relative importance of some menu items or restaurant brands by using information on frequency of consumption or sales information.

With obesity remaining an ongoing problem for public health, it is important to identify ways to support consumers who wish to consume less dietary energy in restaurants. Some of the previous suggested approaches have been taxation of calories, mandatory restriction of portion sizes, and restriction of restaurant locations.[70–74] It is also suggested that giving consumers the right to request half or one-third portions at proportional pricing could potentially be highly effective if implemented[74] and would not restrict what restaurants offer and would increase the customers' option to choose foods in quantities of their choice. Since consumers are likely to eat more when portion sizes larger,[11] having the option to pre-order a smaller amount of any menu item may help reduce energy intake when eating out, while still providing customers with the opportunity to order any type of meal. However, research is needed to determine what regulatory alternatives would be effective and how they could be implemented. In addition to legislative efforts, changes implemented by restaurants such as improving the healthfulness of default choices may be helpful. One recent study found that improving the healthfulness of children's menu options had only a small effect on menu prices and resulted in increased orders for fruits, vegetables, and milk and decreased orders for french fries and desserts.[75] However, in that study total menu calories did not change, suggesting that restaurant-initiated changes of these kinds might be most effective as additions to proportional pricing initiatives rather than as alternative options.

CONCLUSION

The results of this study not only confirm that there were substantial increases in the portion size, energy content, and sodium content of fast food between 1986 and 2016, but also identify an important increase in dietary variety and particular increases in the energy content and variety of dessert offerings. Research is needed to explore the types of regulatory changes, industry-led efforts, and behavioral support that can help consumers reduce energy intake in fast-food restaurants as part of measures to improve dietary-related health issues in the United States.

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STATEMENT OF POTENTIAL CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

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AUTHOR CONTRIBUTIONS

S. B. Roberts conceived and designed the study. S. Appeadu and M. A. McCrory assembled and coded the data. A. G. Harbaugh, M. A. McCrory, and S. Appeadu analyzed the data. M. A. McCrory and S. Appeadu and wrote the drafts with contributions and edits from A. G. Harbaugh and S. B. Roberts. A. G. Harbaugh, M. A. McCrory, S. Appeadu, and S. B. Roberts interpreted the data. All authors reviewed and commented on the final draft.