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# 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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## 1 **Research Snapshot**

2

3 Research Question: How did the portion size, energy, and micronutrients for fast foods in U.S  
4 restaurants from 1986-2016 change over time overall and when grouped by menu category and  
5 restaurant?

6

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

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

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26

27 **Abstract**

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29 Background: US national survey data shows fast food accounted for 11% of daily caloric intake  
30 in 2007-10.

31

32 Objective: To provide a detailed assessment of changes over time in fast food menu offerings  
33 over 30 years, including food variety (number of items as a proxy), portion size, energy, energy  
34 density, and selected micronutrients (sodium, calcium, and iron as % Daily Value (DV)), and to  
35 compare changes over time across menu categories (entrees, sides, and desserts).

36

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

39

40 Statistical Analysis: Descriptive statistics were calculated. Linear mixed effects ANOVA was  
41 performed to examine changes over time by menu category.

42

43 Results: From 1986 to 2016, the number of entrees, sides, and desserts for all restaurants  
44 combined increased by 226%. Portion sizes of entrees (13 g/decade) and desserts (24 g/decade),  
45 but not sides, increased significantly, and the energy (kcal) and sodium of items in all three menu

46 categories increased significantly. Desserts showed the largest increase in energy (62  
47 kcal/decade) while entrees had the largest increase in sodium (4.6 %DV/decade). Calcium  
48 increased significantly in entrees (1.2 %DV/decade) and to a greater extent in desserts (3.9  
49 %DV/decade), but not sides, while iron increased significantly only in desserts (1.4%  
50 DV/decade).

51

52 Conclusions: These results demonstrate broadly detrimental changes in fast food restaurant  
53 offerings over a 30-year timespan including increasing variety, portion size, energy, and sodium  
54 content. Research is needed to identify effective strategies that may help consumers reduce  
55 energy intake from fast food restaurants as part of measures to improve dietary-related health  
56 issues in the United States.

57

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

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62 **Introduction**

63 Approximately 40% of U.S. adults aged 20-74 years are obese, up from around 13% in 1960-62  
64 and 23% in 1988-94.<sup>1</sup> In turn, obesity is the second leading risk factor for disability and the  
65 fourth leading risk factor for mortality in the United States.<sup>2</sup> Fast food, defined as “easily  
66 prepared processed food served in snack bars and restaurants as a quick meal or to be taken  
67 away”,<sup>3</sup> has been positively associated with adiposity and daily caloric intake.<sup>4,5</sup> It has also been  
68 observed that for each additional meal eaten outside of the home, adult Americans are likely to  
69 increase calorie intake by about 100-200 kcal/day.<sup>6,7</sup> An integral part of the average American  
70 diet, fast food accounted for 4% of total caloric intake in 1977-78,<sup>8</sup> while in 2007-10, it made up  
71 11% of daily total caloric intake.<sup>4</sup> Restaurant foods tend to have large portion sizes as well as  
72 high energy density,<sup>9,10</sup> two factors that have been causally associated with higher energy  
73 intake.<sup>11-14</sup> Furthermore, several observational studies have shown that frequency of eating away  
74 from home is positively associated with a higher body mass index (BMI) and increased risk for  
75 chronic health conditions like hypertension, obesity, and insulin-resistance.<sup>9,15,16</sup>

76

77 Cross-sectional studies show that fast food consumption is associated with a diet higher in  
78 sodium.<sup>6,17</sup> and though controversial, excess sodium intake has been linked with hypertension in  
79 prospective studies and randomized clinical trials.<sup>18</sup> With the exception of sodium, there has  
80 been relatively little attention paid to the micronutrient content of fast foods. However, away

81 from home eating has been associated with lower serum concentrations of essential  
82 micronutrients in American adults,<sup>19</sup> with fast food consumption specifically related to a diet low  
83 in micronutrient density.<sup>20,21</sup> While between 1971-74 and 1999-2000, data from the National  
84 Health and Nutrition Examination Surveys (NHANES) indicated an increase in mean intake of  
85 iron,<sup>22</sup> many women aged 19-50 years do not receive enough iron. The prevalence of iron  
86 deficiency U.S. women of childbearing age is estimated at 10.4% for nonpregnant and 16.3% for  
87 pregnant women, with greater prevalences among non-Hispanic black, Mexican American, or  
88 women of “other” race/ethnicities than white women.<sup>23</sup> In addition, Americans do not consume  
89 adequate amounts of calcium compared with the recommendation.<sup>24</sup> The prevalence of low bone  
90 mass in U.S. adults > age 50 years is 43.9%, and of osteoporosis is 10.3%.<sup>25</sup> There is strong  
91 evidence that low calcium intake throughout life, but particularly during childhood and  
92 adolescence, contributes to the development of osteoporosis and is one of several dietary factors  
93 that plays a role in bone health.<sup>26</sup> Osteoporosis increases the risk of bone fracture, especially hip  
94 fracture, which can lead to death due to pneumonia-associated immobility.<sup>27</sup>

95  
96 Previous studies have shown an increase in portion size and portions consumed from fast food  
97 items over time coincident with the obesity epidemic<sup>28,29</sup> Apart from portion size, reports on  
98 changes over time in fast food menu item nutritional composition have been studied as far back  
99 as 1996 and up to 2016 but in separate reports.<sup>30-40</sup> While previous studies show both energy and  
100 portion size have increased, none have included an assessment of energy density, a dietary factor  
101 that promotes energy intake<sup>41</sup> and is suggested to be important for weight control.<sup>42,43</sup> In  
102 addition, no studies have reported on changes in calcium or iron. Moreover, most previous  
103 reports have either studied a small number of restaurants or restricted evaluations to a small

104 subset of restaurant food offerings and nutrients of interest. Therefore, there is a need for more  
105 comprehensive as well as a more recent analysis of changes in a wide variety of dietary  
106 variables.

107  
108 The purpose of this study was two-fold: 1) to provide a detailed description of changes over time  
109 in portion size, energy, energy density, and selected micronutrients of public health interest  
110 (sodium, calcium, and iron) in food items of 10 of the major U.S. fast food restaurants based on  
111 sales <sup>44</sup> in 1986, 1991, and 2016; and 2) to examine these changes by menu category (entrees,  
112 sides, and desserts) and restaurant. The hypothesis was that over time, portion size, energy,  
113 energy density, and sodium have increased, while calcium and iron decreased in each menu  
114 category over time.

115

## 116 **Methods**

### 117 Data Collection

118 Data from 10 fast food restaurants presented in the 1986 and 1991 versions of The Fast Food  
119 Guide <sup>45,46</sup> and online through primary (the restaurant website) or secondary <sup>47,48</sup> websites for  
120 2016 data were used. For about 30 menu items, 2017 websites were used. The Fast Food Guide  
121 provides information on the energy and nutrient content of fast food menu items, health effects  
122 of fast food consumption, and guidance on making educated choices for consumers who choose  
123 to eat fast food. For any energy or nutrient data that were missing from the primary website, data  
124 from a secondary website were used if available. The 10 restaurants were Arby's, Burger King,  
125 Carl's Jr, Dairy Queen, Hardee's, Jack in the Box, KFC, Long John Silver's, McDonald's, and  
126 Wendy's. These restaurants were chosen because the nutritional information on the key

127 nutritional variables of portion size, energy, and sodium were available for each of the three  
128 years being analyzed. These 10 restaurants were in the QSR50, the top 50 quick service and fast  
129 casual restaurants for U.S. sales in 2014, and nine of the 10 were in the top 20.<sup>44</sup> Fast food  
130 restaurants excluded that were in the top 20 for sales in either 1986, 1991, and/or 2016 were (in  
131 alphabetical order) Big Boy, Chick-fil-A, Church's, Domino's Pizza, Little Caesar's, Papa  
132 John's, Pizza Hut, Popeye's Famous Fried Chicken, Roy Rogers, Sonic Drive-In, Taco Bell.<sup>44-46</sup>  
133 To be included in the analysis, restaurants were required to have at least three food items for  
134 each dietary variable examined (e.g. portion size) per menu category (entrees, sides, and  
135 desserts) for at least two of the analytical years (1986, 1991, and/or 2016). Restaurants not  
136 meeting these requirements were excluded from analysis of energy and nutrients by menu  
137 category and/or restaurant, and analytical year. In addition, calcium and iron data in all three  
138 analytical years were available from only four of the 10 restaurants (Arby's, Dairy Queen,  
139 McDonald's, and Wendy's). Individual foods with no data available for the nutritional variables  
140 available were not used in the analysis of energy and nutrients (<1% of entrees, sides, and  
141 desserts across the 10 restaurants). For the analysis of the number of food items available as  
142 entrees, sides, or desserts, food items were included regardless if the nutritional information was  
143 available. For food items with multiple item sizes (e.g. French fries), all available sizes were  
144 included in each year for the reasons that the number of items could have changed over time (e.g.  
145 1 item in one year, 2 or more items in another year) and their portion sizes could also have  
146 changed over time but not proportionately for each size item. Beverages (except for items listed  
147 as milkshakes, shakes, or malts), condiments, and multi-component dinners or platters were  
148 excluded for the following reasons. All beverages were excluded because not all restaurants  
149 specified beverage sizes and data were not available for each analytical year. Condiments were

150 also excluded because data were available for only two of the analytical years from four of the  
151 restaurants. All multi-component dinners or platters and combo meals were excluded because  
152 these were not on the menus of any of the 10 restaurants in this analysis in 1986, and were only  
153 on menus for 1991 and 2016 in some of the restaurants. This study is exempt from IRB approval  
154 given that it is not human subjects research.

155

### 156 Food Categorizing System

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

172 sandwich from Arby's. **Table 1** shows the broad food types assigned to entrees, sides, and  
173 desserts menu categories.

174

#### 175 Calculations and Statistical Analysis

176 Energy density was computed in kcals per gram from the portion size (grams) and energy (kcals)  
177 data. In addition, sodium, calcium, and iron data were all converted to % daily value (%DV) to  
178 allow for comparisons across years because in The Fast Food Guides,<sup>45,46</sup> sodium data were  
179 given in mg, and calcium and iron were given as %U.S. RDA, but in 2016, data for each of these  
180 were given as %DV. For sodium, across all analytical years %DV sodium in food = (mg  
181 sodium/2,400 mg)\*100%, where 2400 mg was the DV for sodium in 2016<sup>49,50</sup> and there was no  
182 DV for sodium in 1986 or 1991.<sup>50</sup> For calcium and iron, because the U.S. RDA and DV were the  
183 same across all analytical years (1000 mg for calcium and 18 mg for iron,<sup>49,50</sup> no conversion  
184 was needed and all are expressed as %DV in 2016. In addition, mg of calcium and mg iron in the  
185 menu items were derived from the %U.S. RDA and %DV values using the following formulae.  
186 For calcium: %U.S. RDA (or %DV) calcium x 1000 mg = mg calcium in food; for iron: %U.S.  
187 RDA (or %DV) iron x 18 mg = mg iron in food. Sodium, calcium, and iron values were also  
188 expressed as density in mg/g and %DV/100 kcal.

189

190 SPSS<sup>51</sup> and R, version 3.4.3<sup>52</sup> was used for basic analyses. In addition, the lme4 package<sup>53</sup>, an  
191 addition to the R base code, was used for all linear mixed-effects modeling. A significance level  
192 of  $\alpha = 0.05$  was used throughout. When multiple analyses with related subsets of the data set  
193 were conducted, a Bonferroni adjustment is provided. To analyze the changes over time in fast  
194 foods across the 10 restaurants being considered, descriptive statistics were computed for the

195 number of food items, portion size (g), energy (kcal), energy density (kcal/gram), sodium  
196 (%DV), calcium (%DV), and iron (%DV). The energy and nutrient data were generally not  
197 normally distributed, but due to the number of data points available, the non-normal distribution  
198 was considered to have little impact on the results. Therefore the mean, standard deviation, 25<sup>th</sup>  
199 and 75<sup>th</sup> percentiles were used to summarize the data.

200  
201 To examine changes over the 30 year time-window, linear mixed-effects (LME) models were  
202 computed. LME models allow for the assessment of linear trends that may vary slightly based on  
203 nesting in the data. In this context, there are two crossed levels of nesting: observations nested  
204 within restaurants and observations nested within the same food types (a nesting that is more  
205 coarse than nesting by menu item name, but more refined than nesting by 1 of 3 meal  
206 components see **Table 1**). Nesting at the food type was well justified (as inclusion of the random  
207 intercept for different food types was statistically significant for all of the dependent variables  
208 under study ( $p$ 's <0.001). The same was nearly observed for the nesting observed at the  
209 restaurant level (all but 3 of the  $p$ 's  $\leq 0.001$ ). Consequently, the restaurant random intercept was  
210 included in all subsequent models.

211  
212 To further assist in understanding the variability in the data, the menu items were more broadly  
213 grouped into three distinct meal components, entrées, sides, and desserts, as described above. To  
214 examine the usefulness of the LME models, multiple regression models were performed adding  
215 the meal component, then the time variable, and then the interaction of the meal component and  
216 time (thus allowing for different slopes for time for each of the different meal components). For  
217 all dependent variables, at least one of the time, slope, or the interaction between meal

218 component and time was statistically significant. This suggests that for all of the dependent  
219 variables, at least one of the meal components significantly changed over time. Instead of  
220 presenting the multiple regression models with time, meal component, and interaction term,  
221 (which would require adding multiple parameters to estimate slope effects for different  
222 components), dependent variable models are presented for each meal component separately, as  
223 this allows for an easier assessment of the statistical significance of the time effect for each  
224 variable.

225  
226 Lastly, to check for possible differences in annual change in energy and nutrients between items  
227 that were identified as consistent across all three time points vs. those that were added or  
228 removed at various time points, an additional linear mixed-effects model was performed. Food  
229 items were dummy coded as consistent across all three time points or not (1 for yes and 0  
230 otherwise) based on the menu item name. This consistency variable was added to the model in  
231 which year and the interaction were fixed effects, while random effects for the intercept and year  
232 were included for the type of food classification, and a random effect for intercept was included  
233 for restaurant. A significant interaction effect indicated the annual change was different for the  
234 consistently labeled items in comparison with the annual change for all other items.

235

## 236 **Results**

### 237 Changes in number of food items overall and by menu category

238 Across the 10 fast food restaurants, the number of items available per year as entrees, sides, and  
239 desserts increased substantially (**Figure 1**). Overall, the number of food items in these categories  
240 combined increased by 62% in the five year period between 1986 and 1991, with the number of

241 desserts more than doubling and the number of entrees and sides increasing by 51% and 40%,  
242 respectively. Over the next 25 years, there was continuing growth in the number of food items  
243 but the rate of change was slower, with the number of entrees and desserts more than doubling  
244 (121% and 111% increase, respectively), and the number of sides increasing by 45%. Over the  
245 30-year period, there was a 226% increase in the number of entrees, sides, and desserts  
246 combined, representing a mean increase per year of 22.9 food items. The restaurant with the  
247 lowest relative increase in menu items was Wendy's (increasing by 89% over the 30-year  
248 period), that with the lowest increase in items per year was Long John Silver's (increasing by 0.6  
249 food items per year), and the most extreme increase was observed at Dairy Queen (increasing by  
250 391% over the 30-year period, representing 5.6 additional food items per year).

251

#### 252 Changes in portion size, energy, and energy density by menu category

253 Descriptive statistics including mean, SD, and 25<sup>th</sup> and 75<sup>th</sup> percentiles for portion size, energy,  
254 and energy density at each time point by menu category are shown in **Table 2**. Portion sizes  
255 (**Figure 2A**) of entrees and desserts increased significantly over time, 1.3 and 2.4 grams/year on  
256 average (13 and 24 g/decade, respectively). The portion size of sides did not change significantly  
257 over time. On the other hand, the energy per item of all three menu categories increased  
258 significantly over time (**Figure 2B**), with desserts showing the largest increase, on average (62  
259 kcal/decade), and entrees showing the next largest increase (30 kcal/decade). Energy density  
260 changes over time (**Figure 2C**) showed a small but significant decrease for entrees (-0.03  
261 kcal/gram/decade), no significant change for sides, and a small but significant increase for  
262 desserts (0.06 kcal/gram/decade).

263

264 Changes in sodium, calcium, and iron by menu category

265 Sodium, calcium, and iron expressed as %DV are described in **Table 3 and Figure 3(A-C)**. The  
266 actual and predicted means, predicted trendline, and spread of the individual data points for these  
267 micronutrients are shown in Figure **3(A-C)**. There were significant increases over time in sodium  
268 (%DV) for all three menu categories, with entrees having the most marked average increase (4.6  
269 %DV/decade), followed by sides (3.9 %DV/decade). Desserts showed a smaller average increase  
270 in sodium (1.2 %DV/decade). The significant increase in sodium in entrees and sides remained  
271 even when the increase was normalized for energy (4.6 %DV/100 kcal in entrees, 3.9 %DV/100  
272 kcal in sides) or portion size, with the exception of desserts (data not shown). Calcium increased  
273 significantly in entrees (1.2 %DV/decade) and to a greater extent in desserts (3.9 %DV/decade),  
274 with no significant change in sides. Calcium density (%DV/100 kcal) also increased significantly  
275 in sides (1.1 %DV/100 kcal/decade) but not in entrees or desserts (data not shown). Iron  
276 increased significantly in desserts (1.4 %DV/decade), while there were no significant changes in  
277 entrees and sides. When normalized for energy (%DV/100 kcal), iron decreased significantly in  
278 entrees (-0.4 %DV/100 kcal/decade) and increased significantly in desserts (0.2 %DV/100  
279 kcal/decade).

280

281 Changes in items that remained vs did not remain on the menus at all three time points

282 Analysis of the differences in changes over time in energy and nutrient contents of items that  
283 remained on the menus in all three analytical years (n=57) compared with other items showed  
284 significant differences in some nutritional variables for entrées but not for sides or desserts.  
285 Specifically, entrée portion size, energy, and sodium for items that remained on the menu in all  
286 three analytical years showed significantly *smaller increases* over time compared with other

287 items (portion size  $\Delta=13.6$  g/decade less,  $p=0.004$ ; energy  $\Delta=37.9$  kcal/decade less,  $p<0.001$ ; and  
288 sodium  $\Delta=5.1$  %DV/decade less,  $p<0.001$ ).

289

## 290 **Discussion**

291 This paper describes changes in portion size, number of restaurant offerings, energy content,  
292 energy density, and sodium of entrees, sides, and desserts from 10 major fast food restaurants  
293 over the past 30 years, the longest period of time published to date. Iron and calcium from 4  
294 restaurants, two micronutrients of importance for public health for which changes in fast food  
295 have not previously been reported, are also included. The major findings were that there were  
296 large mean increases in energy and sodium for entrees, sides, and desserts, and in portion size for  
297 entrees and desserts from 1986 to 2016. Furthermore, there were substantial increases in the  
298 number of foods across and within menu categories, indicating a greater variety of food choices  
299 available, and the additional choices were not all healthy, as evidenced by the increased  
300 distribution of data toward higher values over time for portion size and energy of entrees and  
301 desserts, and sodium for all three menu categories. Combined, these results indicate a broader  
302 range of unhealthy changes in fast food offerings than previously indicated.

303

304 The 30-year increase in portion size among entrees and desserts in the present study is consistent  
305 with previous reports over different periods of time and/or for a smaller number of food items  
306 .<sup>29,54</sup> The marked increases observed in the energy content of entrees and desserts is consistent  
307 with the previous 14-year study which examined menu item changes from 1997-8 to 2009-10,<sup>30</sup>  
308 but most studies conducted on a more limited number of foods and restaurants did not identify  
309 this trend.<sup>32,36,39</sup> In addition, the 226% increase in the number of foods (a surrogate for variety)

310 among entrees, sides, and desserts is particularly noteworthy and is consistent with previous  
311 studies over shorter periods of time and fewer restaurant chains which reported 53%<sup>30</sup> and 18%  
312 <sup>35</sup>, and more broadly trends for increasing dietary variety in the U.S. food supply<sup>55</sup>. A larger  
313 portion size and greater variety of foods, particularly of energy dense foods, are two of the key  
314 factors strongly suspected of contributing to the obesity epidemic<sup>56,57</sup> because both increased  
315 portion sizes and increased variety result in an increase in energy intake acutely, which may not  
316 be fully compensated at other eating occasions.<sup>56,58</sup>

317  
318 Dietary sodium is also a nutrient of great public health interest, and in the present analysis, sodium  
319 increased among all three menu categories, but with the greatest increases seen in entrees and side  
320 dishes. These increases were beyond those expected due to the increases in portion size or energy,  
321 as indicated by the increases in sodium density values, with the exception of desserts in which the  
322 increase in sodium over time was proportional to the portion size increase. These results are in  
323 agreement with studies on changes in sodium in fast food from 2005 to 2011<sup>34</sup> and 1997/98 to  
324 2009/10 for entrees but not sides,<sup>37</sup>. However, they are not in agreement with studies which  
325 reported on a limited number of foods<sup>38,39</sup> or over a shorter period of time.<sup>32,40</sup> Over 80% of  
326 Americans consume sodium at or above the recommendation level.<sup>24</sup> As excess sodium has been  
327 linked to hypertension, a major risk factor of stroke and cardiovascular disease<sup>59</sup>, reducing instead  
328 of increasing sodium in fast food restaurants could potentially impact the incidence of these fatal  
329 diseases. The U.S. food industry has recently made progress in voluntarily reducing sodium as  
330 recommended by the FDA and the results of this analysis suggest that national health could  
331 possibly improve if fast food restaurants follow suit.<sup>60</sup>

332

333 Calcium showed the greatest increases in desserts followed by entrees, while iron showed the  
334 greatest increases in desserts, all which were statistically significant. It was expected that both  
335 calcium and iron would decrease over time, thus the observed changes were inconsistent with  
336 our hypotheses. Calcium's increase in foods overall could have been heavily influenced by Dairy  
337 Queen which contributed a large number of dairy-based desserts. However, though certain  
338 populations of Americans struggle to get enough iron and calcium,<sup>23,25</sup> fast food should not be  
339 the primary source of these micronutrients as they also tend to be high in calories and added  
340 sugars.<sup>33,35</sup> Increases in type 2 diabetes, for which excess added sugar consumption may be a  
341 major risk factor<sup>61</sup>, have been associated with higher obesity rates in the U.S.<sup>62</sup> and adults with  
342 obesity tend to consume a diet less rich in micronutrients than their leaner counterparts.<sup>63</sup>

343  
344 The entrée items that remained on the menu on all three analytical years showed smaller  
345 increases over time for portion size, energy, and sodium, than for other entrée items which were  
346 newly introduced or discontinued, suggesting that changes in the nutritional value of the menu  
347 offerings as a whole were unhealthful, despite the fact that some restaurants may have offered a  
348 selection of more healthful items in recent years.<sup>36,64,65</sup> However, the offering of at least some  
349 healthful items on fast food restaurant menus is a welcome change that should be supported, and  
350 may in part be due to the implementation of the Affordable Care Act which includes federal  
351 menu labeling legislation.<sup>66</sup> A recent analysis<sup>67</sup> which compared the energy content of large  
352 chain restaurant menu items in common in 2008 (before passage of the ACA) and also in 2012-  
353 2015 (after the passage of the ACA) showed an overall slight reduction in mean energy in 2015  
354 versus 2008, suggesting that at least some menu items may have been reformulated to be lower  
355 in calories, either through a reduction in portion size or change in macronutrient distribution, and

356 is supported by some <sup>31,36,68</sup> but not all <sup>69</sup> other studies with comparisons before and after menu  
357 labeling. Bleich et al. also found that mean calories among newly introduced menu items  
358 decreased from 2012-2014 <sup>64,65</sup> though not significantly so when 2015 was included <sup>67</sup>, and that  
359 these decreases were largely influenced by new entrees and menu items not core to the business  
360 in chains with a specific focus (e.g. burgers or pizza). The present study was not able to account  
361 for changes due to the ACA because of the 25 year gap in data from 1991 to 2016. Despite some  
362 positive changes in recent years, fast food menus remain unhealthful overall, especially when  
363 one considers our analysis was on *ala carte* items. If a meal includes one entrée and one side,  
364 using the mean values of these in 2016 (from Table 2), the meal would total 767 kcals, or 38.5%  
365 of a 2000 kcal diet. Using the 75<sup>th</sup> percentile values, the meal would total 1010 kcals, or 50.5%  
366 of a 2000 kcal diet. These meal examples are likely underestimates because they do not include  
367 estimates for beverage or dessert items.

368

369 The present study has both strengths and weaknesses. It is an analysis of a broader set of dietary  
370 factors in fast food restaurants and is a model for other studies to continue to track changes in  
371 fast foods. The study was also an aggregate of multiple restaurants, multiple variables of  
372 nutritional composition, and multiple menu categories, and included breakfast items and desserts,  
373 which are frequently overlooked. However, in some cases the categorization of foods to menu  
374 categories were subjective. In addition, the conclusions for calcium and iron were made based on  
375 four of the 10 restaurants, respectively because those data were not available for the other  
376 restaurants. Another limitation is that while combo meals and multi-component meals/platters  
377 are commonly consumed, these were excluded from analysis because they were not present on  
378 the menus in 1986, and were only in select restaurants in 1991 and 2016. Likewise, the present

379 analysis only takes into account individual *a la carte* items as they were presented on the menu,  
380 and does not account for the combinations in which people order or consume them. Finally, the  
381 analysis did not take into account the relative importance of some menu items or restaurant  
382 brands by using information on frequency of consumption or sales information.

383

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

401

**402 Conclusion**

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

409

410

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595

596 **Figure Captions**

597 **Figure 1.** Number of fast food menu items per analytical year available as entrees, sides, and  
598 desserts, and the three types combined.

599 **Figure 2 (A through C).** Actual changes and linear mixed model-estimated changes in fast food  
600 portion size (A), energy (B), and energy density (C) by menu category and analytical year. Each  
601 pair of bars shows the actual mean $\pm$ SE on the right bar and model estimated mean $\pm$ SE on the left  
602 bar. Grey dots represent data points in each analytical year. *P*-values are shown on each graph,  
603 but significance is established at  $\alpha=0.05/3 = 0.017$  (Bonferroni adjustment).

604 **Figure 3 (A through C).** Actual changes and linear mixed model-estimated changes in fast food  
605 sodium (A), calcium (B), and iron (C) by menu category and analytical year. Each pair of bars  
606 shows the actual mean $\pm$ SE on the right bar and model estimated mean $\pm$ SE on the left bar. Grey  
607 dots represent data points in each analytical year. *P*-values are shown on each graph, but  
608 significance is established at  $\alpha=0.05/3 = 0.017$  (Bonferroni adjustment).

**Table 1.** Food types assigned to the different fast food menu item categories for analysis of energy and nutrient content in 1986, 1991, and 2016<sup>a</sup>.

Menu Category	Food Types
Entrees	Breakfast items (burritos and sandwiches), Burgers, Cereal, Chicken, Eggs, Hot Dogs, Pasta, Pastries, Potato bowls, Salads, Sandwiches, Seafood, Soup, Tacos/burritos/wraps/quesadillas
Sides	Beans, Breads/rolls/biscuits, Cheeses (cottage, curds), Chips, Eggs (side menu), French fries, Fried snacks (other than French fries), Fruit, Meat (side menu), Pasta/rice (side menu), Potato (other than French fries), Salad (side menu), Sandwich (side menu), Soup (side menu), Tacos/burritos/wraps/quesadillas, Vegetables, Yogurt
Desserts	Brownie, Cakes, Cookies, Fruit, Ice cream/frozen yogurt, Milkshake/shake/malt, Pastries, Pies, Pudding

<sup>a</sup> Meals/combo meals not included, beverages not included, breakfast items integrated into entrees, 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 (e.g. pastries) or side dish (e.g. pasta). In the latter case, the entrée would typically be larger than the side dish.

**Table 2.** Portion size, energy, and energy density in menu items from fast food restaurants in 1986, 1991, and 2016.<sup>a</sup>

	Entrees			Sides			Desserts		
	Foods (n)	Mean±SD	(Q <sub>1</sub> ,Q <sub>3</sub> )	Foods (n)	Mean±SD	(Q <sub>1</sub> ,Q <sub>3</sub> )	Foods (n)	Mean±SD	(Q <sub>1</sub> ,Q <sub>3</sub> )
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)

<sup>a</sup> Menu food category types entrees, 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. Q<sub>1</sub>, Q<sub>3</sub> indicates the inter-quartile range, which are the 25<sup>th</sup> and 75<sup>th</sup> percentiles, respectively.

**Table 3.** Sodium, calcium, and iron in menu items from fast food restaurants by menu category in 1986, 1991, and 2016.<sup>a</sup>

	Entrees			Sides			Desserts		
	Foods (n)	Mean±SD	(Q <sub>1</sub> ,Q <sub>3</sub> )	Foods (n)	Mean±SD	(Q <sub>1</sub> ,Q <sub>3</sub> )	Foods (n)	Mean±SD	(Q <sub>1</sub> ,Q <sub>3</sub> )
<b>Sodium (%DV)</b>									
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)
<b>Calcium (%DV)</b>									
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)
<b>Iron (%DV)</b>									
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)

<sup>a</sup> 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) while calcium and iron were available from 4 restaurants (Arby's, Dairy Queen, McDonald's, and Wendy's). Q<sub>1</sub>, Q<sub>3</sub> indicates the inter-quartile range, which are the 25<sup>th</sup> and 75<sup>th</sup> percentiles, respectively.

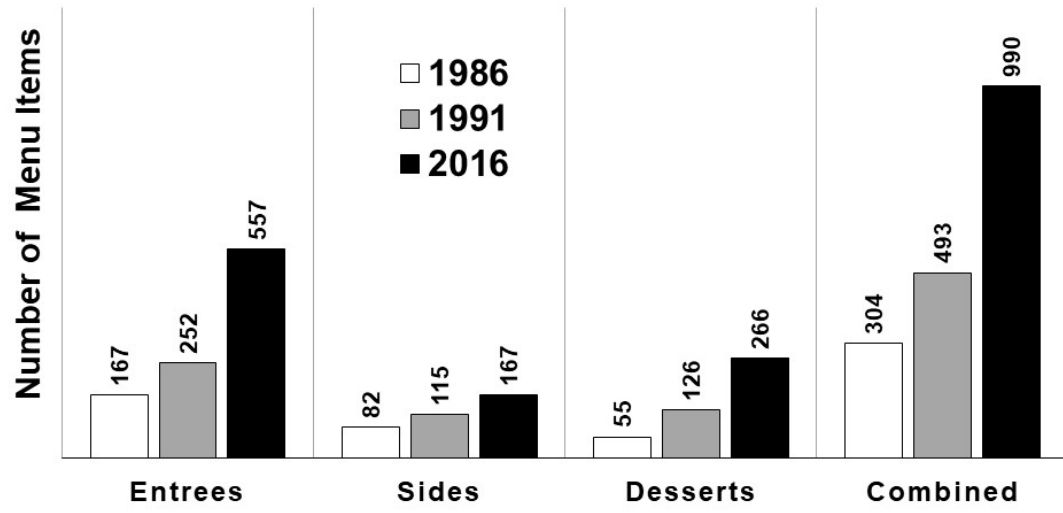


Figure 1

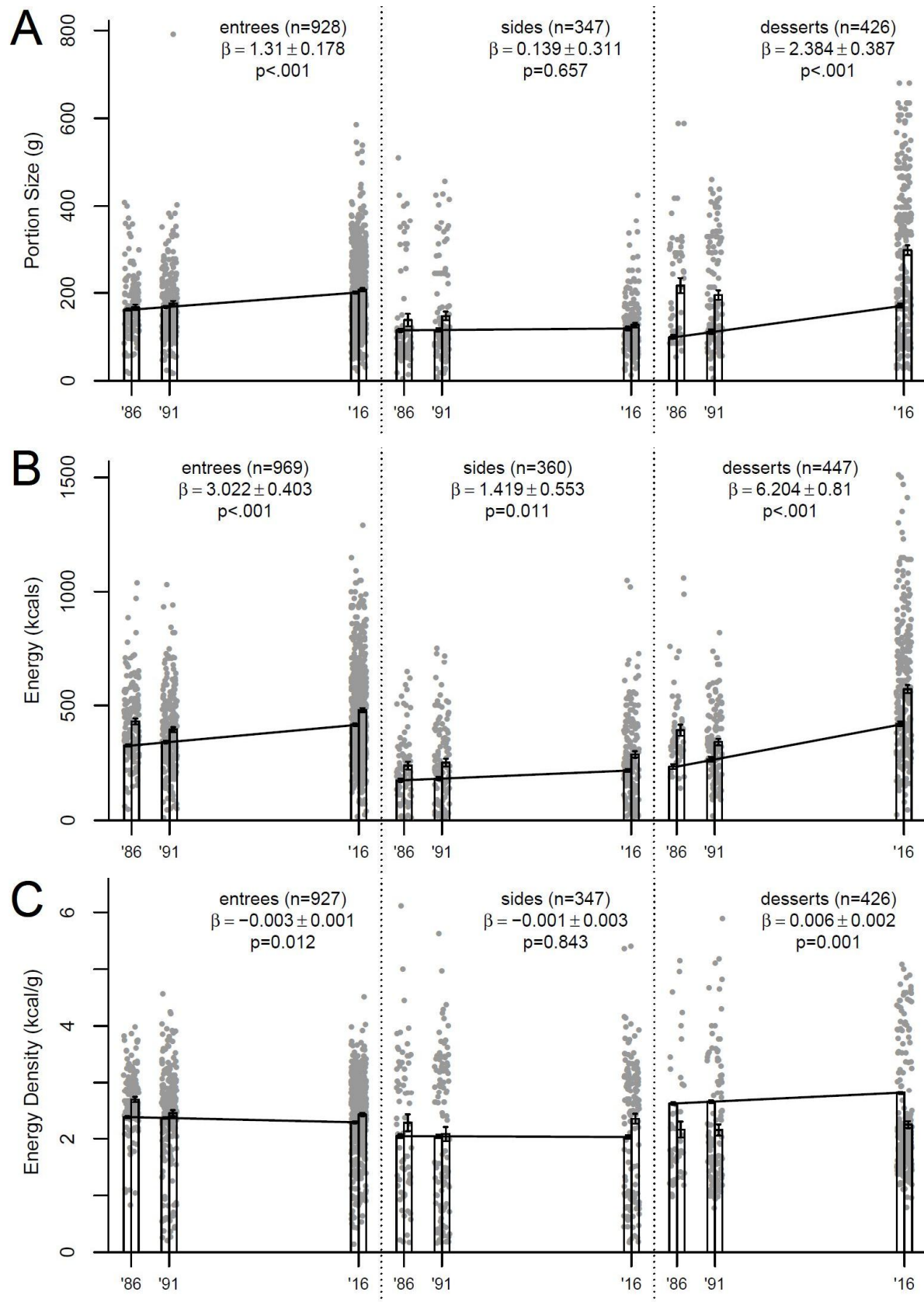


Figure 2

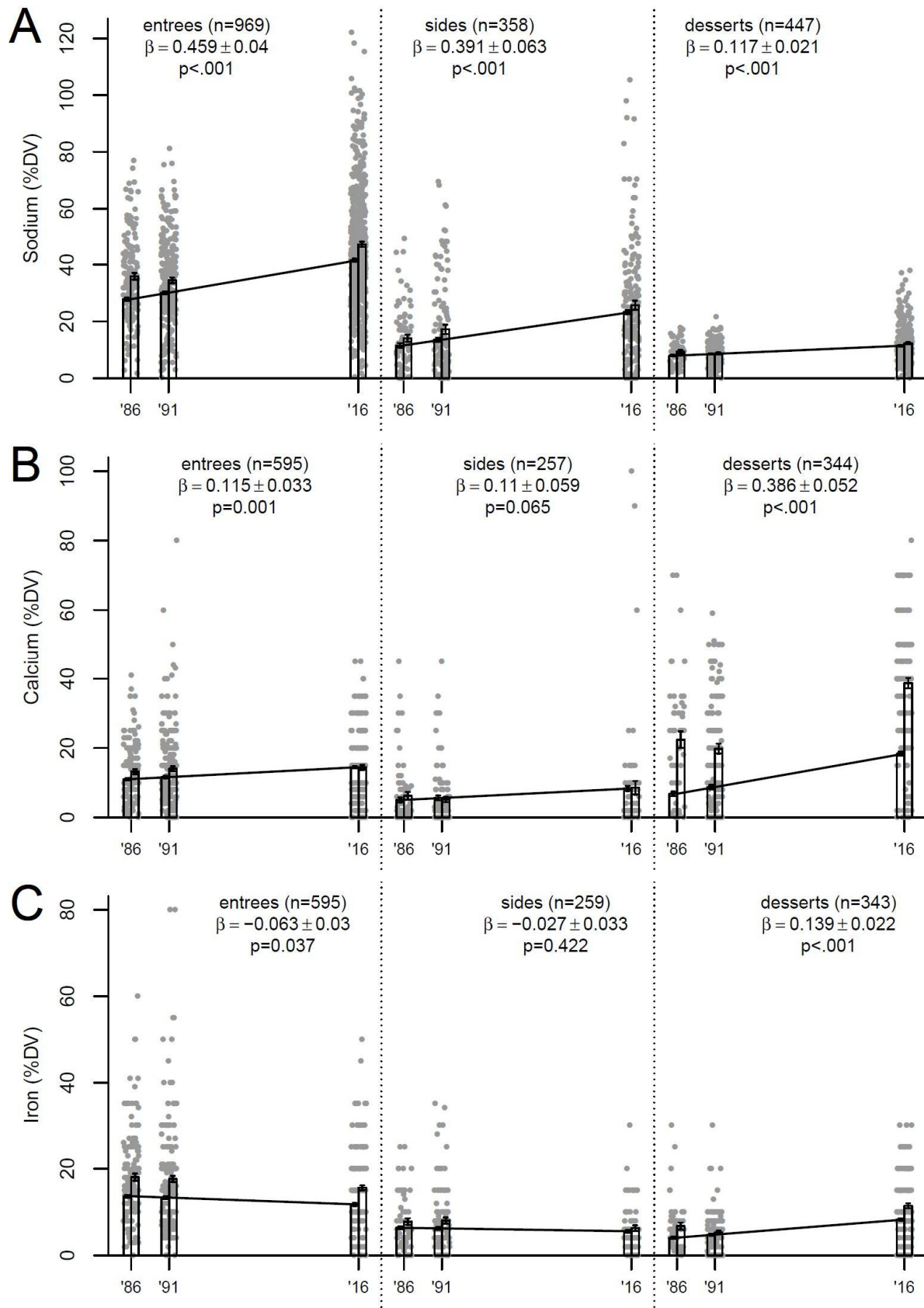


Figure 3