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DISSERTATION

What's on the Menu?

Evaluating the Food Environment in Restaurants

Helen W. Wu

This document was submitted as a dissertation in September 2012 in partial fulfillment of the requirements of the doctoral degree in public policy analysis at the Pardee RAND Graduate School. The faculty committee that supervised and approved the dissertation consisted of Jeffrey Wasserman (Chair), Roland Sturm, and Chloe Bird.

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Published 2012 by the RAND Corporation
1776 Main Street, P.O. Box 2138, Santa Monica, CA 90407-2138
1200 South Hayes Street, Arlington, VA 22202-5050
4570 Fifth Avenue, Suite 600, Pittsburgh, PA 15213-2665
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Acknowledgements

This dissertation is the product of many others' support in my five-year journey through the Pardee RAND Graduate School (PRGS). My dissertation committee member, co-author for Essays 1 and 2, and closest advisor in this work, Roland Sturm, took me from the idea to the end product, and was quick to respond with suggestions on how to make this work something I will be proud of for years to come. My dissertation committee chair, Jeffrey Wasserman, provided years of ongoing support and mentorship in both my on-the-job training and academic work. My dissertation committee member Chloe Bird formally introduced me to the concept of social determinants of health, which is so pervasive in food and nutrition issues. Finally, my outside reader, Barbara Bruemmer, shared both the insights and sympathy that can only come from someone else who has bravely endeavored to study the same topic.

The PRGS faculty patiently taught me the art and science of research and policy analysis, through both classroom instruction and applied project work. The PRGS staff worked tirelessly to support the students and maintain the school's standing now and into the future as the world's leading producer of PhDs in policy analysis. My fellow students could be called upon nearly 24/7 to answer questions and provide feedback, especially my entering class of 2007 and my friends and colleagues Adam Gailey, Ethan Scherer, and Chris Sharon.

I am grateful to those who provided funding to make this work possible. The Robert Wood Johnson Foundation (RWJF) provided a grant through its Healthy Eating Research Program to the RAND Health unit, under which I carried out the bulk of this research. The RWJF and

RAND media and communications teams were essential to helping this work reach a broader audience through the general media. PRGS internal sources of support were many: the JL Foundation and Rothenberg Dissertation Awards, Santiago Morales Scholarship, and Kip Hagopian Pre-Dissertation Seed Grant. Additional support from PRGS and RAND Health projects to attend professional conferences helped develop my knowledge of obesity research, network with researchers and public health practitioners working on this timely policy issue, and share my work with outside audiences.

The honor of earning a PhD from PRGS requires a feat of extreme endurance, persevering to overcome many internal and external challenges along the way. Although conferral of the degree is recognized as an individual accomplishment, the success is a shared one. To the entire support crew that helped me reach this finish line, you have my eternal gratitude.

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Overview

The food environment today is fundamentally different than it was in previous decades, when obesity levels were lower and people had less salt in their diets. The various types of food outlets (e.g., grocery/convenience stores, school/work cafeterias, and restaurants), their physical accessibility, and the nature of food options within them have all changed to create a food environment that has been labeled toxic and "obesogenic." Restaurants are one key component of the food environment, and if they are part of the problem, they could be part of the solution.

Many health conditions are linked to diet – "you are what you eat" – but dietary choices are not made independently of external influences. Rather, they are heavily shaped by the context of this new food environment. Cardiovascular disease remains the leading cause of death in the United States, and obesity and diabetes are epidemics. These health risks can be reduced through lower dietary intake of energy, salt, trans fat, and saturated fat, but asking individuals to bear the full responsibility for making healthy choices is unrealistic within the current food environment. In order to advance our understanding of the role that restaurants can play in mitigating these health issues, more research is needed to evaluate the current and changing nature of the food environment with respect to restaurants.

This dissertation is comprised of three essays that each ask the question, "what's on the menu?" in major U.S. chain restaurants, and that each answer it in a way that aims to broaden our understanding of the role of restaurants in the current food environment. Essay 1 represents the largest study to date describing the state of nutrition across a broad set of chain restaurants. It reports on the energy and nutrition content for more than 30,000 regular and children's menu items across 245 restaurant brands. It paints a dismal portrait of menu offerings, finding that almost no main entrées (only 4%) fall within one-third of the calorie, sodium, saturated fat, and fat levels recommended for adults by the U.S. Department of Agriculture (USDA). Essay 2 is a one-year follow-up analysis that provides a snapshot of the evolving nature of restaurant main entrées between 2010 and 2011, before and after the passage a new national menu labeling law. It finds some weak indicators of sodium reductions, but concludes that overall, changes in entrées did not shift the overall balance in a healthier direction. Essay 3 applies a scenario analysis approach to illustrate the range of conditions under which males and females at various ages could meet USDA nutrition guidelines for sodium through changes in fast food restaurant intake alone. It shows many groups for whom even eliminating restaurant meals completely would not be enough, and it makes a case for much bigger food industry-wide reductions than we have seen. It also shows why consumers have such a hard time meeting nutrition guidelines, given the menu options available.

In response to the major role of restaurants in the U.S. diet, recent policy activity targeting restaurants has been high, including new laws to increase consumer awareness about calorie information and to intervene directly in the market by banning harmful ingredients such as artificial trans fats. However, relatively little is known from a research perspective about what restaurants look like and how they evolve, and this work provides a unique contribution to the limited body of evidence. Together, these three essays tell a story about the role that restaurants play in the food environment, while pointing to the potential for improving population health through policy, public health, and industry efforts.

Essay 1. What's on the Menu? A Review of the Energy and Nutritional Content of U.S. Chain Restaurant Menus

Authors: Helen W. Wu and Roland Sturm

Prior publication as: Wu HW, Sturm R. (2012). What's on the menu? A review of the energy and nutritional content of US chain restaurant menus. Public Health Nutrition 1(1):1-10. Epub available ahead of print: May 12, 2012.

Abstract

Objective: To describe nutrition information availability in major chain restaurants, describe energy and nutritional levels of menu items, evaluate relationships with restaurant characteristics, menu labeling and trans fat laws, and nutrition information accessibility, and compare energy and nutritional levels against industry-sponsored and government-issued nutrition criteria.

Design: Descriptive statistics and multivariate regression analysis of the energy, total fat, saturated fat, trans fat, sodium, carbohydrate, and protein levels of 29,531 regular and 1,392 children's menu items.

Setting: Energy and nutrition information provided on restaurant websites or upon request, and secondary databases on restaurant characteristics.

Subjects: The top 400 U.S. chain restaurants by sales, based on *Restaurants & Institutions* magazine's 2009 list.

Results: Complete nutrition information was reported for 245 (61%) restaurants. Appetizers had more energy, fat, and sodium than all other item types. Children's menu specialty beverages had more fat, saturated fat, and carbohydrates than comparable regular menu beverages. The majority of main entrées fell below one-third of the USDA estimated daily energy needs, but as few as 3% were also within limits for sodium, fat, and saturated fat. Main entrées had significantly more energy, fat, and saturated fat in family style than fast food restaurants. Restaurants that made nutrition information easily accessible on websites had significantly less energy, fat, and sodium across menu offerings than those providing information only upon request.

Conclusions: This paper provides a comprehensive view of chain restaurant menu nutrition prior to nationwide labeling laws. It offers baseline data to evaluate how restaurants respond after laws are implemented.

Introduction

Restaurants play a major role in the American diet – 82% of U.S. adults eat out at least once a week.[(1)] Restaurant meals have increased their share of total energy intake over time,[(2)] and increased consumption of food away from home is associated with poorer diet quality and higher intake of energy, fat, and sodium.[i,(3)]

Consumers cannot accurately estimate the nutritional content of restaurant foods, and several states and municipalities, led by New York City in 2008, passed menu labeling laws.[(4)] These initial efforts were superseded by the Patient Protection and Affordable Care Act of 2010 (ACA), which made calorie labeling on menus a national requirement for restaurants with 20 or more outlets nationwide as of March 2010, although some provisions do not take effect until the Food and Drug Administration (FDA) finalizes regulations.[(5)]

The discussion on the effects on menu labeling has almost exclusively focused on consumer responses to a fixed menu.[(6-11)] Business responses are not well documented in the research, despite the fact that restaurants regularly introduce new items and occasionally reformulate existing ones. In fact, there is not even a comprehensive assessment of nutrient information across the restaurant industry, an essential requirement for future evaluations of the federal legislation. This research fills this gap by describing how chain restaurant menu offerings shape the food environment faced by children and adults.

[i] Sodium, as used throughout this dissertation, refers to table salt, which is predominantly NaCl.

Two prior studies analyzed the availability of nutrition information, and one analyzed menu nutritional content. In 2004, 44% of the largest 300 U.S. chain restaurants by sales provided nutrition information on websites or upon request.[12] Also in 2004, among 15 table service chain restaurants operating in Minnesota, 10 provided some nutrition information, but 9 of those 10 only provided data for items with specific health claims, such as "heart healthy" or "low fat."[13] It is likely that these rates substantially changed even before the passage of the ACA, due to state and local regulations. One study considered nutritional content of restaurant menus, but it was limited to 12 fast food restaurants.[14] Population-based dietary survey studies have analyzed self-reported intake, but energy and nutritional values were estimated indirectly from databases.[15]

This paper reports the status of data availability and nutritional content of menus in the largest U.S. chain restaurants just prior to the passage of the ACA. It analyzes the availability of data, updating results from earlier studies, and provides the first study that systematically analyzes nutritional content across such an extensive and diverse of set of restaurants. Research questions are: 1) what is the availability of data on standard menu offerings at major U.S. chain restaurants, 2) what are the energy and nutritional levels of those menu offerings, 3) how do those levels relate to restaurant characteristics, existing state/local labeling laws or trans fat bans, and ease of data accessibility, and 4) what proportion of items appears to meet restaurant industry-supported and government-issued nutrition criteria?

Methods

Study Population

The study population was identified by the 2009 *Restaurants & Institutions* magazine list of top 400 U.S. chain restaurants based on 2008 sales.[16] These restaurants had a combined 206,750 U.S. outlets, representing approximately one-third of all U.S. restaurant outlets in 2010, based on analysis from the InfoUSA database.[17]

Data Collection

Data were collected from February-May 2010 by reviewing restaurant websites for nutrition information. The data collection timeframe overlaps with when the menu labeling provision of ACA was passed (March 2010), but federal implementation rules were still pending in early 2012. When the website did not provide this information, an e-mail request was sent to request it. Restaurants were counted as having complete nutrition information available if energy was listed for the majority of standard menu items. Information for selected nutrients and sodium were also collected when available: total fat, saturated fat, trans fat, total carbohydrates, sodium, and protein. Data that were inconsistently reported (e.g., serving size, sugar, fiber, vitamins) were excluded. Restaurants classified as not having complete information: 1) did not offer a standard preparation for at least 50% of menu items (e.g., menu based fully on "build-your-own" customizations) (n=5), 2) only provided information for a minority of the menu (e.g., "healthy choices" only) (n=20), 3) did not provide information on the website nor provide contact information to request it (n=4), or 4) did not provide information on a website nor respond to an e-mail request for it (n=126). Complete nutrition information was available for n=245 (61%) restaurants, representing 176,711 (85%) of outlets in the initial study population. Characteristics of the 155 (39%) restaurants (representing 30,039 (15%) of outlets) not providing complete nutrition information are described in the results.

Nutrition information was entered following implementation guidelines for California's menu labeling law[18] where possible (as proposed federal guidelines were not published at the time of data entry). A key feature was that values represent the restaurant-defined single serving size for an item's standard preparation; the detailed data entry protocol can be found in Appendix A. The entire item was entered as a single serving if not specified otherwise. Add-ons/toppings and condiments were excluded unless served as part of the item's standard preparation. Alcoholic beverages were excluded. Every individual, unique item and size on the standard and children's menu for selected item types (main entrée, appetizer, side, salad, salad dressing, soup, dessert/baked good, and specialty non-alcoholic beverage) was coded. If items had customization options, the high and low energy values were entered as separate menu items. Catering platters and family size items were excluded unless individual serving portions were noted. Items not designed for individual in-restaurant consumption were excluded (e.g., whole pies).

Indicator variables were created to compare distinct nutrition criteria (Table 1.1): the National Restaurant Association (NRA)-supported Healthy Dining and Kids LiveWell criteria for energy, fat, saturated fat, and sodium,[19] and one-third of the U.S. Department of Agriculture (USDA) 2010 Dietary Guidelines.[20] For USDA estimated energy needs, a daily threshold of 2,000 kcal was used as the basis for adults, and for children ages 4-8 and 9-13, the mid-range average for moderately active females and males for each respective age group was used (1,600 and 1,900).[20] Taking one-third of the USDA RDA is a conservative benchmark for a single meal, as

Americans report about 5 eating occasions a day, typically 3 main meals and 2 snacks,[21] and fast food restaurant visitors order an average of 2.4 menu items.[22] It closely follows the 32% USDA benchmark for children's dietary intake used in the Yale-Rudd Center Fast Food FACTS report[14] and Institute of Medicine Committee on School Meals National School Lunch Program recommendations,[23] although school lunch recommendations use different age groups and higher energy and nutrient levels, in order to ensure adequate intake. Unlike school lunches which are complete meals, this study calculated per single serving size for a main entrée, rather than for a typical meal ordered (such information was not available from the data).

Data on restaurant characteristics come from two secondary sources. The Research Report for Foodservice ("RRFS," based on the Restaurantchains.net database), a tri-annual phone survey of restaurant executives, provided data on restaurant operating characteristics.[24] The InfoUSA 2010 business database provided outlets by location.[17] Finally, a literature review was conducted to identify menu labeling laws and trans fat bans at the city, county, and state levels that were effective prior to data collection and might influence the formulation of restaurant menu offerings.[25-28] The analytic variable is the percentage of a restaurant's outlets subject to such laws.

Statistical Analysis

Analysis was conducted using Stata/IC version 10.1. In addition to descriptive statistics, a logistic regression model analyzed whether or not a restaurant provided complete energy information (as the dependent variable) as a function of restaurant characteristics. For restaurants with complete nutrition information, energy and nutritional values of main entrées were analyzed using ordinary least squares multivariate regression with robust standard errors and clustered residuals by restaurant, with no weighting by number of outlets. Main entrées with fewer than 100 or more than 5,000 kcal were excluded; despite being listed as main entrées, those items typically represented substantially less/more than a full meal for one individual (e.g. one chicken wing or 50 chicken wings).

Independent variables were restaurant characteristics (meal periods offered, service model, cuisine type, and national outlet count), degree of web-based information accessibility (readily accessible in one page/file, requiring multiple clicks to view information per item, or requiring an e-mail request for information), and percentage of the restaurant's outlets subject to an existing menu labelling or trans fat policy. Outlet count was analyzed as a decile-level variable, probably a more robust data specification than outlet counts, which had a very skewed distribution due to a few restaurants with a very large number of outlets.

Results

Restaurant Characteristics

Characteristics for the initial study population are shown in Table 1.2. By service type, family style accounts for the most brands, but fast food accounts for the most outlets. By cuisine, the largest number of brands serves American cuisine, but the largest number of outlets serves snacks, burger, or sandwiches (although American cuisine is fourth). The reason is that the number of outlets varies by service type and cuisine.

Predictors of Information Accessibility

Logistic regression analyses were used to estimate the odds ratio (OR) of reporting nutrition information at the $p<0.05$ level of significance, using the initial study population of 400 restaurants to compare those that did not report complete information with those that did. By service type, fast casual restaurants had significantly higher odds (OR 3.06, 95% CI 1.08, 8.65) of providing nutrition information than fast food restaurants, and upscale restaurants were significantly less likely to do so (OR 0.21, 95% CI .05, 0.92), with no significant differences by other service types. By cuisine, burger and sandwich restaurants had significantly higher odds (OR 7.16, 95% CI 1.47, 34.84, and 7.61, 95% CI 1.44, 40.19 respectively) of reporting information compared to American restaurants, with no significant differences by other cuisine types. Decile of outlet count was significant at $p<0.001$ (OR 1.30, 95% CI 1.17, 1.45); larger chains were more likely to provide information. Surprisingly, existing state/local menu labeling laws had no independent effect. Having more outlets subject to trans fat bans had a significantly higher OR (1.03, 95% CI 1.02, 1.04), but the magnitude was negligible.

Energy and Nutritional Content of Menu Offerings

Descriptive statistics for the energy and nutritional levels of menu items, by type, are shown in Table 1.3. The data included 30,923 unique menu items (29,531 regular and 1,392 children's menu items) from the 245 restaurants that provided information. All items required energy values to be included, but nutritional values were reported less consistently (trans fat in particular).

For regular menu items, appetizers stand out as having the highest values of energy, fat, saturated fat, and sodium, compared to all other menu item types, even main entrées. Salads combined with dressing values have nutritional values approaching those of main entrées. Quartiles are also shown. The 75th percentile, for example, means that 1 in 4 appetizers exceeds 1,146 kcal and 2,660 mg sodium, and that 1 in 4 main entrées exceeds 2,000 mg sodium.

Children's menu items are expected to have smaller portions, and thus be lower in nutritional values than the corresponding regular menu item type. For the most part, this was true, the glaring exception being beverages. Children's menu specialty beverages had more energy, fat, saturated fat, and carbohydrates at most percentiles than specialty, non-alcoholic regular menu beverages.

Figure 1.1 illustrates how selected item types might fare against the restaurant industry-supported Healthy Dining and Kids LiveWell nutrition criteria, for regular and children's menu items, respectively. This analysis estimates maximum percentages of items that would pass, as it did not include ingredient criteria, for which data were not available. For regular menu items, up to 42% of main entrées, 39% of sides, 16% of desserts/baked goods, and 6% of appetizers might pass the Healthy Dining standards. Children's menu items did not fare as well with Kids LiveWell standards, with a maximum of 11% of main entrées and 33% of sides passing, not taking into account ingredient criteria.

Figure 1.2 compares main entrées against the conservative benchmark of one-third of the USDA guidelines. Children's menu main entrées are compared to one-third of USDA estimated energy intake and RDA values for two age groups defined in the USDA dietary guidelines; adolescents' needs are similar to adults' needs. The majority of main entrées fell within estimated energy needs for adults (57%) and children (67-80%) , but fewer fell within RDA limits for fat and sodium. When main entrées were assessed to see if they fell within estimated energy needs and RDAs for fat, saturated fat, *and* sodium simultaneously, a much smaller proportion fell within these limits (between 3-4% for adults and 8-11% for children), compared to Healthy Dining and Kids LiveWell criteria. The finding suggests that the actual percentage of complete meals that meet nutritional criteria as well as energy needs, as typically consumed, is likely to be very small.

Predictors of Energy/Nutritional Content for Main Entrées

Table 1.4 shows the results of regressing item-level energy and nutrition variables for main entrées on restaurant-level variables. Depending on the outcome measure, the model's R^2 explained between 12.9 and 21.5% of total variation.

Across all outcome measures, family style restaurant menu items consistently had significantly higher levels of energy, fat, and sodium compared to fast food restaurant items, and coefficients were large. Fast casual restaurant menu items also had significantly higher energy levels on average, but not significantly higher levels of fat or sodium. The menus for restaurants serving breakfast had lower energy, sodium, and protein levels, on average. Pizza and chicken restaurant menu items had significantly lower levels of most nutritional values compared to American restaurant menu items. Most cuisines had significantly lower levels of sodium than the American cuisine, and some differences were quite large.

While the regression analysis is limited to restaurants providing nutrition information, there were differences in how easily information could be accessed online. Restaurants that only provided information upon e-mail request had significantly higher energy and nutritional values than those that provided the information on their website in a readily accessible single file or page. There was no significant effect for the proportion of outlets subject to a state/local labeling policy, and while coefficients for the proportion of outlets subject to a trans fat ban were significant, their magnitude was essentially zero.

Discussion

This paper provides a snapshot of the availability of nutrition information and nutritional content of menu offerings among the largest U.S. restaurant chains just before the ACA mandate that requires nationwide menu labeling of calories. Prior research has documented the impact of restaurant dining on overall diet quality,[3, 29] and for nutritional content in selected fast food restaurants,[14] but none have systematically sampled this many restaurants across such diverse service types and cuisines.

One reason for the absence of prior studies was the lack of nutrition information in the past. Harnack found that only 3 of 15 table service restaurants provided complete nutrition information on their websites in 2004-2005, and no restaurants without website information provided it upon e-mail request.[13] Wootan and Osbourn found that 44% of U.S. chains in the *Restaurant & Institutions* magazine list reported nutrition information on websites in 2004,[30] compared to this study's 61% in 2010. The increase may stem from enhanced website content, consumer demand for information, and state/local laws requiring nutrition information. This study updates and expands on prior research by reporting on how nutrition information accessibility varies by cuisine and service type, finding evidence that restaurants making information less readily accessible also have menu items that are higher in energy, fat, and sodium.

Although this study provides a more extensive measure of nutritional content in the largest U.S. chain restaurants than previously available, there are multiple limitations. Because data were intentionally collected prior to complete ACA implementation, the self-reported and usually web-based nutrition information was not subject to standardized format requirements and is likely to have variable accuracy.[31] For instance, the finding that family style restaurant entrées have higher energy than fast food restaurant entrées could be an artifact of how data were reported, if family style restaurants' nutrition information on entrées counted sides without noting this – although the extent to which this occurred was unclear.

Another limitation is that the restaurants studied capture a large share of the market, but large chains are obviously not representative of the universe of all restaurants. One market research group estimated that 37% of restaurant brands are independents, not chains or non-commercial operations.[32] Individual restaurants and small chains may offer food with systematically different nutritional content, but they are not subject to menu labeling laws.

Additionally, we cannot comment on nutritional content for restaurants that did not make information available. Even among the largest U.S. restaurants, those with fewer outlets and those considered “upscale” (e.g., Legal Sea Foods, Ruth’s Chris Steak House) are less likely to report data. Upscale restaurant websites often noted that accurate nutritional analysis was not possible, due to customizations and less strictly standardized food preparation methods. Results for upscale restaurants and trans fat levels should be viewed with caution, due to high non-reporting rates and thus probable reporting bias.

Finally, comparison to Healthy Dining and Kids LiveWell standards was based on available data, which notably did not include sugar or ingredients – additional criteria needed to determine whether items fully met those standards. The proportion of menu items characterized as meeting those standards is therefore higher than it would be if full data were available.

This study describes energy and nutritional levels of menu offerings in order to provide a baseline set of values on the critical supply side issue about what restaurants offer, but it is not a study of how menu offerings affect demand, choice, or dietary quality. It did not evaluate the influence of price, marketing, or bundling/combination meal strategies, which are known to be highly influential,[33, 34] or ordering/intake patterns.[35] This study analyzed items without weighting either by sales or outlets, although restaurants with more outlets will have a bigger impact on the U.S. population’s diet.

Main entrées appear surprisingly low in energy when viewed a la carte and on a per-serving basis, but nevertheless have high levels of sodium or saturated fat. This may be an artifice of restaurant-determined single serving size, and also must be interpreted in light of what is typically ordered and consumed at restaurant meals. Dumanovsky et al. found that in three fast food restaurants, only 19.4% of purchases were single items, whereas 70.9% of purchases were dollar meal menu combinations of two or more items.[35] Market research data find that fast food patrons order 2.4 menu items, on average, and that only 21% of children 6-12 years old order kids' meals at fast food restaurants.[22] That gives more cause for alarm, given the high sodium content in individual items. How people combine items may also differ across restaurant types and combination orders are likely to be different in family style restaurants than in fast-food restaurants.

There were significant differences in nutritional content of menu items, particularly for some service types and cuisines. Some may be reporting artifices and reflect a limitation of how restaurants report data, including self-determined serving sizes (e.g., appetizers reported as multiple servings in some restaurants but not all). In particular, some pizza and (fried) chicken restaurants had surprisingly low energy content in main entrées because they used unusually small serving sizes (e.g., 1 slice of pizza, 1 chicken piece). This provides a clear indication that serving sizes need to be standardized for menu labeling to offer meaningful comparisons. There is less ambiguity in the finding that family style restaurants offer substantially higher energy, fat, and sodium items. This may be due to larger portion sizes and/or higher energy density. Larger portion sizes can contribute to higher energy intake and weight gain over time in adults and children.[36-40] Family style restaurants and, independently, American cuisine, also offer main entrées with higher sodium levels. Sodium intake in the U.S. is far higher than USDA-recommended levels, generating substantial social costs due to morbidity and excess health care expenditures.[41]

While children's main entrées were lower energy than regular menu ones, as they should be, children's menu specialty beverages were often dessert-like, sugary items such as milkshakes. They typically had more energy, fat, and saturated fat than non-alcoholic, regular menu specialty beverages, which included more smoothies and coffee and tea specialty beverages. Over the past few decades, beverage-only snacking occasions increased considerably in children,[(21)] and the percentage of energy intake from beverages increased in non-Hispanic black 12-19 year olds.[(42)] School-based policies targeting sugar-sweetened beverages have focused on soft drinks and vending machines; this study provides data about specialty beverages served in restaurants.

The data also show that the proportion of items meeting USDA, Healthy Dining, and Kids LiveWell criteria is: 1) highly sensitive to specific criteria (e.g., a generous sodium threshold), 2) substantially lower when nutritional values are considered in addition to energy, and 3) potentially very different for USDA vs. Healthy Dining and Kids LiveWell. Healthy Dining's sodium limit of 2,000 mg per main entrée could allow up to 6,000 mg/day intake across three meals – 2.6 times the USDA RDA for adults and 4 times that for adults with low sodium needs – without considering other items ordered. Many items met a single nutrition criterion, but far fewer satisfied multiple criteria. Thus, many items that may be perceived as falling within USDA-recommended levels based on energy alone, which is the only value that will be added to menus under ACA, would not meet other nutritional standards. Finally, a much larger proportion of main entrées could meet Healthy Dining and Kids LiveWell criteria, compared to one-third of USDA RDA limits, suggesting that restaurant industry-supported criteria are more generous than government-established ones. Although comparisons were based on partial data (e.g., without sugar, ingredients), it is clear that restaurant industry-supported criteria differ from USDA ones –

particularly for sodium. The Healthy Dining and Kids LiveWell logos are used on many chain restaurants' menus to highlight "healthy choices," but they provide a vastly different picture than USDA guidelines. Misleading health claims used by grocery manufacturers on front-of-package labeling has been a concern for federal regulators.[43] This study provides evidence that restaurant industry labeling also deserves further discussion.

Conclusion

There is not compelling evidence that labeling alters individual choices from a fixed menu, but restaurant menus change over time, and this study provides baseline data just before national labeling laws go into effect that can be used to assess such changes. Many restaurant menu items are high in fat, saturated fat, and sodium, and restaurant industry-supported logos used to highlight "healthy choices" are more generous than USDA guidelines, particularly for sodium. Menu items that appear reasonable based on energy alone must be considered within the context of an entire meal and for other nutritional values. Sometimes those extras, such as children's specialty beverages, are problematic.

Tables and Figures

Table 1.1. Comparison of Healthy Dining, Kids LiveWell, and USDA Nutrition Standards

Standard	Maximum values						
	Energy (kcal)	Fat (g)	% energy from fat	Sat. fat (g)	% energy from sat. fat	Trans fat (g)	Sodium (mg)
Healthy Dining [a]							
Main entrée	750	25	n/a	8	n/a	n/a	2000
Appetizer, side, or dessert	250	8	n/a	3	n/a	n/a	750
USDA adult [b]	667	n/a	35	n/a	10	1[d]	767
USDA adult w/ low sodium needs [b]	667	n/a	35	n/a	10	1[d]	500
Kids LiveWell [a,c]							
Children's meal	600	n/a	35	n/a	10	0.5	770
Side	200	n/a	35	n/a	10	0.5	250
USDA ages 4-8a [b]	533	n/a	35	n/a	10	1[d]	633
USDA ages 9-13 [b]	633	n/a	35	n/a	10	1[d]	733

[a] Excludes specific ingredient criteria (e.g., inclusion of whole grains, lean meats), for which data were not collected.
[b] Represents one-third of estimated daily energy needs and recommended daily intake (RDA) limits for each group. USDA criteria were applied to main entrées only, which were recorded as a la carte items whenever possible.
[c] Excludes criterion for % of energy from total sugars, for which data were not collected.
[d] No specific limit recommended other than "as little as possible." The analysis used $\leq$1 g as a benchmark.

Table 1.2. Initial Study Population Composition by Brand, Outlet Count, and Subgroup-specific Non-reporting Rate

Characteristic	# brands	# outlets	Avg. # outlets per brand	% brands not reporting, by row subgroup
Service [a]				
Take-out/delivery	39	37,356	958	23%
Fast food	90	119,449	1,327	21%
Fast casual	53	11,842	223	17%
Buffet	12	2,333	194	17%
Family style	172	34,530	201	50%
Upscale	34	1,240	36	88%
Total	400	206,750		
Cuisine [a]				
American	136	26,162	192	46%
Asian	15	2,131	142	60%
Burger	25	38,330	1,533	08%
Chicken	13	13,618	1,048	15%
Italian	33	4,780	145	45%
Mexican	31	10,846	350	32%
Pizza	30	24,028	801	23%
Sandwich	21	33,206	1,581	10%
Snack [b]	47	47,057	1,001	23%
Steak/seafood	49	6,592	135	69%
Total	400	206,750		

[a] Service types and cuisines as reported by Restaurantchains.net database. Service type examples: take-out/delivery (Auntie Anne's, Ben and Jerry's), fast food (KFC, Burger King, McDonald's), fast casual (Au Bon Pain, Panera Bread), buffet (Golden Corral, Sizzler), family style (Denny's, Marie Callender's, Red Lobster), upscale (Capital Grill, Morton's).
[b] e.g., bakery, cafe, coffee, ice cream, frozen yogurt, smoothie restaurant.

Table 1.3. Energy and Nutritional Content of Chain Restaurant Menu Offerings

Statistic	Regular Menu Energy (kcal)	Fat (g)	Saturated fat (g)	Trans fat (g)	Sodium (mg)	Total carbs (g)	Protein (g)	Children's Menu Energy (kcal)	Fat (g)	Saturated fat (g)	Trans fat (g)	Sodium (mg)	Total carbs (g)	Protein (g)
	Main entrée [a]							Main entrée [a]						
Mean	674	32	12	0	1,512	57	34	466	21	8	0	956	47	19
p25	362	14	4	0	745	28	17	305	10	3	0	610	27	12
p50	590	25	9	0	1,291	49	30	420	18	7	0	875	42	18
p75	890	43	16	1	2,000	77	45	599	30	11	0	1,190	63	24
n	13,334	11,204	12,118	6,097	12,943	13,058	10,467	927	750	822	346	915	913	686
	Appetizer													
Mean	813	48	16	1	2,023	60	35	No children's menu items were reported as appetizers						
p25	360	19	5	0	880	25	13							
p50	700	40	12	0	1,675	48	28							
p75	1,146	68	22	0	2,660	87	51							
n	1,191	925	1,018	334	1,119	1,126	805							
	Side							Side						
Mean	260	13	4	0	541	29	8	172	8	2	0	304	22	3
p25	113	3	1	0	170	9	3	90	0	0	0	24	11	1
p50	210	9	2	0	410	23	5	159	6	2	0	210	20	3
p75	340	17	5	0	730	41	10	240	13	3	0	477	29	4
n	3,059	2,685	2,803	1,707	2,979	3,000	2,567	213	181	197	76	213	213	161

Shaded cells indicate where the value of the corresponding regular menu item type is lower than the children's menu.

[a] Represents a la carte items whenever separate values were provided; may include some combination meals when a la carte nutritional values were not provided.

Table 1.3. Energy and Nutritional Content of Chain Restaurant Menu Offerings (cont.)

Statistic	Regular Menu							Children's Menu						
	Energy (kcal)	Fat (g)	Saturated fat (g)	Trans fat (g)	Sodium (mg)	Total carbs (g)	Protein (g)	Energy (kcal)	Fat (g)	Saturated fat (g)	Trans fat (g)	Sodium (mg)	Total carbs (g)	Protein (g)
	Salad [b]							Salad [b]						
Mean	496	28	8	0	1,066	30	24	138	7	2	0	246	10	3
p25	200	9	3	0	400	12	6	60	1	0	0	80	5	3
p50	410	21	6	0	897	20	21	113	4	1	0	190	10	3
p75	710	40	12	0	1,537	40	36	258	10	3	1	349	13	5
n	1,815	1,518	1,637	842	1,756	1,777	1,498	15	13	11	3	15	15	12
	Salad dressing							Salad dressing						
Mean	172	15	2	0	394	7	1	178	17			344	7	1
p25	90	6	1	0	220	2	0	100	10			230	4	0
p50	150	14	2	0	330	4	0	190	20			285	7	0
p75	235	22	4	0	500	9	1	250	23			540	9	1
n	916	800	813	454	894	903	736	10	10	0	0	10	10	10
	Soup							Soup						
Mean	225	11	5	0	1,055	22	9	166	6	4		926	17	10
p25	120	3	1	0	722	14	5	170	1	3		826	14	2
p50	200	8	3	0	990	20	8	180	6	4		920	19	10
p75	280	16	7	0	1,312	27	11	190	10	5		1,050	19	17
n	1,418	1,270	1,291	929	1,399	1,410	1,256	9	2	9	0	9	9	2

Shaded cells indicate where the value of the corresponding regular menu item type is lower than the children's menu.
[b] Includes dressing values only when a single dressing is offered as the standard preparation, per data entry protocol; otherwise does not include dressing.

Table 1.3. Energy and Nutritional Content of Chain Restaurant Menu Offerings (cont.)

Statistic	Regular Menu Energy (kcal)	Fat (g)	Saturated fat (g)	Trans fat (g)	Sodium (mg)	Total carbs (g)	Protein (g)	Children's Menu Energy (kcal)	Fat (g)	Saturated fat (g)	Trans fat (g)	Sodium (mg)	Total carbs (g)	Protein (g)
	Specialty non-alcoholic beverage [c]							Specialty non-alcoholic beverage [c]						
Mean	418	13	8	0	209	69	8	406	15	11	0	179	63	7
p25	220	1	0	0	85	39	3	279	3	6	0	59	52	2
p50	360	8	5	0	170	63	7	430	15	13	0	172	65	10
p75	560	18	12	0	290	93	11	520	20	14	0	280	73	11
n	3,286	2,936	3,017	2,208	3,149	3,267	2,907	84	78	64	13	84	84	70
	Dessert/baked goods [d]							Dessert/baked goods [d]						
Mean	429	19	10	0	302	59	8	240	10	6	0	114	33	4
p25	230	7	3	0	125	32	3	100	2	1	0	52	18	2
p50	354	14	7	0	240	52	6	174	6	5	0	78	24	3
p75	546	26	13	0	414	74	10	310	13	8	0	150	43	4
n	4,512	4,167	4,230	3,318	4,454	4,446	4,123	134	109	127	70	134	134	109
	Total							Total						
n	29,531	25,505	26,927	15,889	28,693	28,987	24,359	1,392	1,143	1,230	508	1,380	1,378	1,050
% missing	0.00	0.14	0.09	0.46	0.03	0.02	0.18	0.00	0.18	0.12	0.64	0.01	0.01	0.25

Shaded cells indicate where the value of the corresponding regular menu item type is lower than the children's menu.
[c] Excludes common soft drinks (e.g., Pepsi/Coke), plain coffee/tea, and alcoholic beverages.
[d] Includes miscellaneous baked goods not labeled as sides (e.g., rolls, bagels, breakfast pastries, cookies).

Table 1.4. Linear Regression: Energy and Nutrition

	Dependent variable											
	Energy (kcal)		Total Fat (g)		Saturated Fat (g)		Sodium (mg)		Carbohydrates (g)		Protein (g)	
Independent variable	Coeff	p	Coeff	p	Coeff	p	Coeff	p	Coeff	p	Coeff	p
Restaurant characteristics												
Meal period												
Serves breakfast	-113.6	0.007*	-5.2	0.051	-1.3	0.236	-374.8	0.000*	-5.7	0.153	-9.8	0.000*
Serves lunch	-46.1	0.698	10.8	0.545	-0.2	0.965	-176.2	0.629	-4.5	0.665	3.9	0.576
Serves dinner	-67.5	0.229	-0.6	0.826	-2.7	0.259	66.6	0.782	-15.7	0.167	3.3	0.672
Service (reference: fast food)												
Take-out/delivery	70.8	0.057	5.1	0.026*	2.0	0.022*	260.4	0.046*	2.7	0.650	4.5	0.155
Fast casual	107.4	0.033*	3.5	0.238	0.8	0.407	131.7	0.299	13.8	0.010*	8.0	0.016*
Buffet	-122.9	0.099	-5.0	0.200	-1.9	0.172	-273.2	0.212	-14.3	0.099	-5.7	0.175
Family style	270.6	0.000*	16.3	0.000*	5.4	0.000*	434.5	0.000*	18.5	0.000*	13.5	0.000*
Upscale	-132.4	0.503	-0.6	0.974	-2.1	0.696	-847.3	0.090	-24.9	0.141	10.4	0.214
Outlet count												
Decile of outlet count	-0.7	0.917	0.1	0.820	0.0	0.830	18.8	0.262	0.3	0.679	-0.3	0.370
Cuisine (reference: American)												
Asian	-216.9	0.069	-19.4	0.004*	-7.1	0.005*	-446.2	0.021*	2.5	0.831	-16.0	0.011*
Burger	1.3	0.975	3.0	0.254	1.2	0.174	-258.1	0.025*	-3.8	0.489	1.8	0.626
Chicken	-136.8	0.015*	-7.8	0.008*	-3.2	0.000*	-483.0	0.000*	-12.2	0.020*	-2.8	0.527
Italian	-70.8	0.229	-8.8	0.010*	-0.1	0.948	-364.3	0.012*	9.9	0.098	-13.0	0.001*
Mexican	-47.0	0.328	-4.7	0.190	-0.2	0.895	-17.9	0.886	9.8	0.024*	-7.1	0.012*
Pizza	-317.3	0.000*	-20.1	0.000*	-6.0	0.000*	-1038.5	0.000*	-9.0	0.330	-19.7	0.000*
Sandwich	39.0	0.619	-2.1	0.636	0.1	0.942	69.6	0.732	13.9	0.057	1.5	0.772
Snack	7.5	0.854	-2.8	0.307	0.1	0.963	-37.7	0.744	10.5	0.048*	-0.7	0.785
Steak & Seafood	-164.1	0.081	-9.4	0.223	-0.8	0.816	-437.3	0.035*	-26.1	0.000*	2.9	0.534
	Prob > F	0.000	Prob > F	0.000	Prob > F	0.000	Prob > F	0.000	Prob > F	0.000	Prob > F	0.000
	R-squared	0.215	R-squared	0.179	R-squared	0.179	R-squared	0.130	R-squared	0.129	R-squared	0.186

*p<0.05

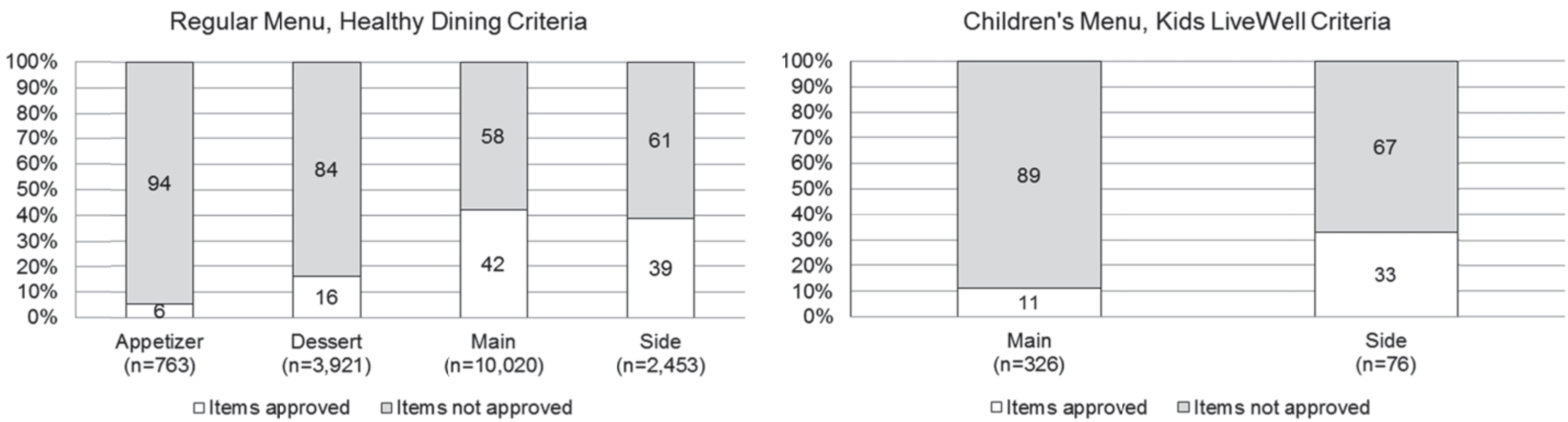
Table 1.4. Linear Regression: Energy and Nutrition (cont.)

	Dependent variable											
	Energy (kcal)		Total Fat (g)		Saturated Fat (g)		Sodium (mg)		Carbohydrates (g)		Protein (g)	
Independent variable	Coeff	p	Coeff	p	Coeff	p	Coeff	p	Coeff	p	Coeff	p
Policy												
% outlets subject to menu labeling [a]	0.1	0.960	-0.1	0.838	0.0	0.712	-4.0	0.400	-0.2	0.456	0.0	0.907
% outlets subject to trans fat ban [a]	1.2	0.014*	0.0	0.225	0.0	0.029*	2.0	0.099	0.1	0.012*	0.0	0.872
Information accessibility *(reference: On website in a single file/location)*												
On website in multiple pages/ per-item info	82.3	0.177	6.7	0.082	3.3	0.042*	-145.9	0.285	1.8	0.751	6.0	0.019*
Not on website, provided upon e-mail request	145.2	0.001*	9.1	0.000*	3.4	0.002*	220.4	0.045*	8.9	0.214	6.8	0.043*

* $p<0.05$

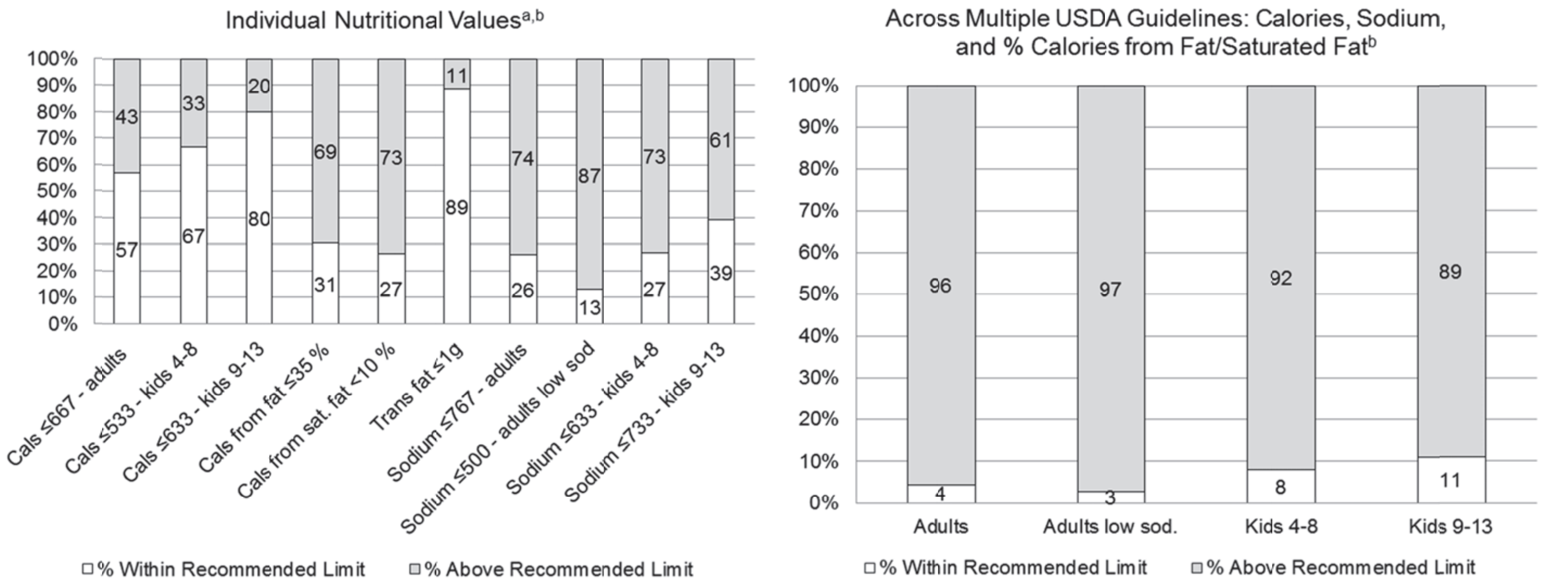
[a] Scale: 0-100

Figure 1.1. Menu Items Meeting Healthy Dining and Kids LiveWell Criteria



Sample size is reduced as analysis includes only menu items with data reported for all nutrition criteria. Data were not available on percentage of energy from sugar (for Kids LiveWell standards) or ingredients (e.g., item includes whole grains, fruits and vegetables, for both standards), so the percentage of items approved estimates maximum possible values.

Figure 1.2. Main Entrées Meeting Subgroup-Specific Values of One-Third of the USDA Estimated Daily Energy Needs and Recommended Daily Allowances



[a] USDA recommendation for trans fat is "as little as possible"; ≤1 g was used as a benchmark.
[b] Values for children were assessed against children's menu main entrées.

Essay 2. The Evolving Food Environment in Restaurants: Tracking Changes in the Energy and Sodium Content of Main Entrées One Year after Passage of a Federal Menu Labeling Law

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Abstract

Background: The food environment shapes individual choices about diet, and as it changes, individual intake of energy and sodium may also shift. Restaurants are a key component of the food environment, and they play an increasing role in the U.S. diet. Understanding whether and how restaurant menu offerings evolve in response to regulatory and public health pressures could inform future efforts to improve the food environment more broadly.

Purpose: To evaluate changes in energy and sodium content of U.S. chain restaurant main entrées over one year.

Methods: Nutrition information was collected from the websites of top U.S. chain restaurant brands in spring 2010 and 2011, comprising 213 unique restaurant brands. Descriptive statistics and regression analysis evaluated change across main entrées overall, and compared the energy and sodium content of entrées that were added, removed, and unchanged. Tests of means and proportions were conducted for individual restaurant brands to see how many made significant healthy or unhealthy changes. A separate analysis was conducted for children's menu entrées.

Results: The mean levels of energy did not change significantly over time, although mean sodium decreased slightly. Trends differed by service model. Family-style restaurants decreased sodium at the 75th percentile, although sodium levels still exceed recommended limits. Fast food restaurants decreased energy in children's menu entrées. Most restaurants did not make significant changes in energy or sodium, although among those that did, there were slightly more healthy changes than unhealthy ones.

Conclusions: Industry marketing and pledges may create a misleading perception that restaurant menus are becoming healthier. However, while some healthy menu changes may occur, unhealthy changes may also occur in a way that offsets most or all of these gains. The magnitude of changes in the food environment must be much larger in order to make progress on public health nutrition goals.

Introduction

A war on obesity is shaping up that pits public health advocates against the food industry, with the former arguing that individual dietary choices are distorted when the industry creates a food environment that makes healthy eating difficult.[44, 45] Restaurants are one key player in this debate, and they could respond to criticism by changing menu offerings in a way that begins to address public health concerns. There is much room for improvement in the nutrition content of restaurant menu offerings. A 2010 review of web-based nutrition information found that only 4% of main entrées at major chain restaurants fell within one-third of the daily intake recommended in U.S. Department of Agriculture (USDA) dietary guidelines for energy, sodium, fat, and sodium fat.[46] Menu changes could be prompted by public health policies such as menu labeling laws, but in general they are influenced by many other factors that include marketing strategy, economic conditions, profit margins, food trends, consumer preferences, demographics.[33, 47-49]

Changes in menu offerings that affect energy, saturated and trans fat, and sodium levels could have implications for the many poor health outcomes related to obesity, blood pressure, and cholesterol levels. Other studies have focused on demand-side changes after the introduction of local menu labeling laws, but found that they have little to no effect on what people order or eat.[7, 11, 50-53] It may be that consumers do not respond because they face a fixed set of options. In the absence of large demand-side shifts in individual behavior, menu labeling policies that generate supply-side changes in restaurant menu offerings could facilitate healthy eating by altering the set of choices that individuals face.

This study aims to quantify supply-side changes in the U.S. chain restaurant industry by tracking the energy and nutritional content of main entrées over a one-year timeframe (spring 2010 to spring 2011). During this time, restaurants faced ongoing internal and external pressures that could influence menu reformulations, with one notable policy shock – the passage of a federal menu labeling provision on March 23, 2010 as part of the Patient Protection and Affordable Care Act (ACA). Section 4205 of the new law amended the Food, Drug, and Cosmetic Act to require chain restaurants with 20 or more U.S. outlets to list, "in a nutrient content disclosure statement adjacent to the name of the standard menu item, so as to be clearly associated with the standard menu item, on the menu listing the item for sale, the number of calories contained in the standard menu item, as usually prepared and offered for sale."[(54)] The law was not formally implemented as of 2012, but some restaurants started to comply early, and others may have started to test menu changes in anticipation of the forthcoming regulations. The nature of menu changes after passage of a menu labeling law provides insight into whether such an information transparency policy, which targets consumer demand, can also encourage supply side changes by restaurants, in the form of healthier menu options.

Methods

This study expands upon previous work that describes the energy and nutrition content of major chain restaurant menu offerings in 2010.[(46)] It provides a one-year follow-up analysis to evaluate changes in main entrées ("entrées," i.e., items designated as main dishes and/or standalone meals by restaurants, and not served as accompaniments or add-ons) after the federal menu labeling law was passed.

Study Population

The initial study population was identified by the 2009 *Restaurants & Institutions Magazine* list of top 400 U.S. chain restaurant brands, based on 2008 sales.[16] Restaurant brands were excluded if they: 1) did not provide nutrition information for at least half their standard menu items at either baseline or follow-up (n=121), 2) did not provide nutrition information at both baseline and follow-up (n=47), or 3) did not have any main entrées at baseline or follow-up (n=19) (e.g., ice cream shops). The final study population was 213 restaurant brands, which comprise a total of 155,021 U.S.-based outlets, and which represent approximately one-quarter of all U.S. restaurant outlets in 2010, based on analysis from the InfoUSA database.[17] Of these 213 restaurant brands, 109 had children's menu data in both time periods. Nearly all of these restaurants (n=207 (97%)) are subject to the federal menu labeling law, based on their national outlet count in 2010.

Data Collection

Nutrition information was collected from restaurant websites, and an e-mail request was sent if no data were posted. Baseline and follow-up data were collected approximately one year apart: between February-May 2010 and April-May 2011. The federal menu labeling law was passed during the timeframe of baseline data collection (March 2010). It is unlikely that baseline data already reflected responses to the law, given the time required to review menus, conduct nutritional analysis, implement changes across a major restaurant brand, and update information on websites. However, follow-up data may reflect initial restaurant responses to the law, as some restaurants had started posting calorie information by then, even though the law was not fully implemented by then. Methods for data entry were described previously.[46] In brief, the lead author entered nutrition information using implementation guidelines for California's menu labeling law[18] where possible, which was poised to go into effect at the time of data entry (federal guidelines were not available at the time of data entry). A key detail is that values represent the restaurant-defined single serving size for an entrée's standard preparation.

The data represent entrées for regular (i.e., non-children's) menus and, where available, for children's menus as well. Data were entered as a la carte entrées whenever information was given in this manner (e.g., fast food combination meals are not included in addition to their corresponding a la carte main entrée), although menu item descriptions were not always clear on whether sides and other items were included. Entrées with fewer than 100 or more than 5,000 kcal were excluded. Despite being listed as entrées, those observations typically appeared to represent substantially less/more than a full meal for one individual.

Data on restaurant brand-level characteristics come from secondary sources. The Research Report for Foodservice (RRFS), a tri-annual phone survey of restaurant executives, provided 2011 data on restaurant characteristics.[24] The InfoUSA 2010 business database provided data on number of outlets at the restaurant brand level.[17]

Analysis

Analysis was conducted using Stata/IC v10.1. Regular menu entrées were analyzed separately from children's entrées. Outcome measures were energy and sodium levels. Independent variables at both the restaurant and item levels were used. Restaurant-level independent variables were: service model (take-out/delivery, fast food, fast casual, family style, buffet, and upscale),[ii] category of chain size based on national outlet count, cuisine type, and meal periods offered. Item-level independent variables were: a follow-up time period indicator, an added (vs. removed) item change indicator, and their combinations (further explanation in Figure 2.1). Interaction terms were included between service model and time period/added item change indicators, in order to identify trends that may have differed, for example, in family style compared to fast food restaurants.

Entrées that changed were classified as removed (appeared on the restaurant's menu nutrition data at baseline but not follow-up – "we don't offer that anymore"), or added (new entrées that did not appear on the baseline menu – "we just started offering this on our menu") based on nutrition data. The added item change indicator flagged non-identical items across time periods within a restaurant, based on the energy and nutrition levels. That means that even if an item had the same name, it was classified as removed in the baseline set and as added in the follow-up set if it was reformulated over time (e.g., the sodium or energy content changed).

In addition to descriptive statistics, data were analyzed at both the item and restaurant level to evaluate trends across all restaurant entrées, as well as those within individual restaurants. Item-level analysis looked for trends across the full set of entrées over time using ordinary least-squares (OLS) regression. Quantile regression was also conducted at the item level to assess change using a measure other than central tendency. This approach can capture changes in other

[ii] See footnote in Table 1.2 for examples of restaurant brands in each service model.

parts of the distribution that might not be detected at the mean, and unlike OLS it is not sensitive to outliers. It is possible that an analysis of means might obscure changes in the distribution of nutrition values. Restaurants might reduce energy for items particularly high in energy, for example, while increasing energy for items that previously had low values. To estimate standard errors when assumptions of heteroskedasticity do not hold, the OLS regression used robust standard errors and clustered residuals by restaurant, and the quantile regression used bootstrapped standard errors.

Outcomes were evaluated using three models: 1) an unadjusted model, 2) a model adjusted for service model and service model interactions, and 3) a model adjusted for service model, service model interactions, and other restaurant characteristics. Results in the unadjusted model show the independent main effect of overall change, which broadly describes the nature of menu entrée changes in restaurants regardless of subgroup-specific differences. Models 2 and 3 include service model interactions, where the main effect of change is conditional on service model. Differences between results in models 2 and 3 indicate whether changes by service model may actually be linked to other restaurant characteristics.

Smaller changes made by an individual restaurant brand to expand healthy menu offerings may not be apparent in an item-level analysis across all entrées, so a restaurant-level analysis was also conducted to supplement conclusions made from the item-level findings. Restaurant-level analysis used one-sided t-tests to evaluate differences in mean energy and sodium within each restaurant, and results summarize the number of restaurants showing significant increases or decreases. To evaluate whether restaurants shifted the percentage of their entrées that fell under specific energy or sodium thresholds, which could signal a marketing-focused healthy menu makeover (for example), the Fisher's exact test for differences in proportions was used. This method is appropriate when some categories of analysis have n<5, which was the case for some restaurants. The threshold used for energy was ≤750 kcal, which corresponds to one of the Healthy Dining program criterion for labeling a restaurant entrée as "healthy."[19] This limit is more generous than what corresponds to one-third of the 2,000 kcal estimated daily energy needs noted by the USDA for many adults, but the Healthy Dining program's use as a marketing tool make it a more relevant target for restaurants looking to promote lower-calorie items. The threshold used for sodium was <1,000 mg sodium, which is two-thirds of the daily upper limit recommended for half the U.S. population;[20] the Healthy Dining criterion is 2,000 mg, which exceeds USDA limits for many groups. Sensitivity analysis using other energy and sodium thresholds was conducted. Clustering of items near the thresholds was inspected graphically and with the Kolmogorov-Smirnov equality-of-distributions test, to assess whether results may be sensitive due to small shifts near the threshold values.

The restaurant-level analysis has limitations. Statistical power to detect differences varies based on the number of entrées in a restaurant, so change of a relatively large magnitude may not be statistically significant in restaurants with few entrées. Results should be viewed within the broader context of all the study's findings. The study aims to evaluate whether the food environment in chain restaurants, as defined by the set of entrées available, changed in a healthy or unhealthy direction. There is no singular measure to answer this unequivocally, and the various item and restaurant-level measures provide a more complete picture of the nature of food environment changes.

Results

The final study population comprised of 213 restaurant brands with 26,256 regular menu entrées combined across baseline and follow-up periods, and a subset of 109 restaurant brands with 1,794 children's menu entrées. Energy and sodium levels of items, by change and follow-up category, are shown in Table 2.1. The number of restaurant brands, by service model, were as follows for the regular/children's menu analyses: take-out/delivery (20/3), fast food (62/21), fast casual (42/24), buffet (7/1), family (79/58), and upscale (3/2). Cuisine types represented in the regular menu analysis were predominantly classified as American (n=67). Other cuisine types were pizza (n=23), burger (n=22), Mexican (n=20), Italian (n=18), sandwich (n=18), snack (n=17) (e.g., bakery, cafe, coffee, ice cream), chicken (n=11), steak & seafood (n=11), and Asian (n=6). Restaurant brands excluded from the final study population were smaller chains with a mean of 277 outlets, compared to 728 outlets for the brands included ($p<0.01$). Characteristics of restaurants not reporting nutrition data were previously described.[46]

Overall Entrée Changes across All Restaurants

Table 2.2 provides an item-level analysis for regular menu entrées (excluding items specific for children), analyzing time-based trends across the full range of menu entrée offerings. It shows whether restaurant menu entrée offerings changed significantly overall, and whether certain service models made bigger changes than others. Main effects by service model account for a large share of the variation in outcomes, and were consistent with those previously reported – most notably, that entrées in family style restaurants have significantly higher energy and sodium levels compared to those in fast food restaurants.[46] In the unadjusted model 1, the mean energy and sodium did not change significantly over time, although some quartiles did in quantile regressions. Family-style restaurant entrées decreased in energy and sodium at the 75th percentile in model 2, although they were higher in energy and sodium to start, so there is more opportunity for change. Within quantile regressions, the direction of change differed by service model, and the results were not robust to different model specifications.

A parallel analysis was conducted for children's menu entrées (detailed results not shown), with results analyzed using an unadjusted model and two adjusted models as with the regular menu analysis. The sample size of children's menu entrées was smaller, especially within some service models (such as upscale restaurants), which do not report nutrition data often.(46) There were no significant time trends at the mean for energy or sodium in the unadjusted model. Fast food restaurants had a significant decrease in mean energy (-40 kcal, p=0.049). In contrast, the two upscale restaurants with children's menu entrées had a significant increase in mean energy (46 kcal, p<0.001) for children's menus. Due to the small sample size, these estimates were not likely to be generalizable to broader industry trends in upscale restaurants.

Comparing Added, Removed, and Unchanged Entrées across All Restaurants

Table 2.3 compares added and removed entrées to look for trends at the margin for the 177 (83%) of restaurant brands that made such changes, excluding items that were unchanged over time, for regular menu entrées. This analysis directly tests the hypothesis of whether added/reformulated entrées were significantly different in energy or sodium than removed/original entrées. Overall and by service model, new entrées added in 2011 were not different in mean energy, compared to entrées that came off the menus since 2010, although they were 70 mg lower in sodium ($p=0.027$). Significant differences in quantile regression analyses are strongest for family style restaurants at the 75th percentile, which showed significant decreases in sodium in both adjusted models. Other significant trends in quantile regression did not hold consistently across model specifications.

A parallel analysis of children's menu entrées (detailed results not shown) found that overall, added entrées were not significantly different in mean energy compared to removed entrées. At fast food restaurants, however, added items were 57 kcal lower ($p=0.047$) than removed ones. These differences existed even in the fully adjusted model (3).

The items that changed over time – whether removed or added – were significantly different from those that did not change. Compared to unchanged items, removed items were 77 kcal and 246 mg sodium higher ($p<0.001$), and added items were 73 kcal and 207 mg sodium higher ($p<0.001$) at the mean, in the regular menu analysis. Thus, restaurant menu entrées changes were not random with respect to energy and sodium compared to items that were unchanged, even though the nature of removed and added items was similar. For children's menus, this difference was not as evident. Items differed by change category only in the removed group, which was 36 kcal lower than unchanged items ($p<0.05$).

As shown in Figure 2.2, trends differed slightly based on service model. Family style restaurants decreased their higher energy and sodium entrées (75^{th} percentile) in added vs. removed items. The opposite trend (although not significant in Table 2.3) was seen in take-out/delivery and upscale restaurants. The inconsistent nature of differences between added vs. removed items was also apparent for children's menu entrées, where the energy/sodium range was smaller in fast food restaurants but larger in fast casual and family style ones.

Changes within Individual Restaurants

Item-level analysis describes changes across the landscape of restaurant menu entrées, but changes within individual restaurants tell a more complete story about the nature of supply-side changes in the restaurant environment, particularly when the direction of changes varies. Table 2.4 summarizes statistical tests for each individual restaurant brand, addressing whether mean energy or sodium changed over time, whether they were different for added vs. removed items, and whether restaurants changed the proportion of their entrées that met Healthy Dining criteria – a restaurant industry-supported program that defines criteria needed to mark items with a "healthy" symbol.[19] The results highlight differences between how many restaurants made significant healthy vs. unhealthy changes to the entrées on their menus.

For most measures, a slightly greater number of restaurants made changes in the healthy direction compared to the unhealthy direction – although most restaurants did not make significant changes. For example, 7% of restaurants had a significant increase in energy levels and 10% had a significant decrease (first row); the difference is 3 restaurants out of 100. Sodium levels were lower in added items vs. removed ones in 17% (n=26) of restaurants, signaling a shift towards sodium reduction – although 7% (n=11) did the opposite. Generally, the magnitude of increase/decrease was similar in restaurants that either increased/decreased energy or sodium, respectively. The 26 restaurants that made healthy changes to sodium in added items did, however, reduce it by 707 mg on average, whereas the 11 that made unhealthy changes to sodium in added items increased it by only 547 mg. Changes to children's menu entrées occurred in only a few restaurants, although for sodium, the average increase for the few restaurants represented was much larger than the average decrease.

Sensitivity analysis for evaluating the proportion of entrées below specific energy and sodium levels indicated that conclusions did not change qualitatively based on the thresholds chosen. Also, the distributions of energy and sodium values around those thresholds were not significantly different in comparison groups, based on the Kolmogorov-Smirnov test of equality of distributions. Therefore, it does not appear that restaurants made small changes just to bring items under certain values, for marketing purposes.

Discussion

Across a broad group of U.S. chain restaurants, our results do not strongly support the notion that the impending implementation of a federal menu labeling law, voluntary efforts by the industry and in partnership with public health entities (e.g., First Lady Michelle Obama's Let's Move childhood obesity initiative and the National Salt Reduction Initiative), market conditions, and consumer demand that faced restaurants between 2010 and 2011 led to sweeping changes in the average energy or sodium content of entrées. A lack of overall change in the food industry is consistent with Turner and Chaloupka's study in schools, which found that despite widespread efforts to curb access to unhealthy competitive foods over time, levels of access remained constant after three years.[55]

If healthy changes did occur, then a sufficient number of unhealthy changes to entrées also occurred to offset such differences on average – a finding that aligns with Glanz et al.'s argument that even if healthier restaurant menu options are offered, they do not have a large presence across the set of menu offerings.[33] A few healthy changes were seen, although the differences are slight: items at higher levels of sodium decreased by 70 mg in added vs. removed items on regular menus, mean energy decreased by 57 kcal in fast food restaurants for added vs. removed children's entrées, and more restaurants significantly lowered energy and sodium compared to those who made changes in the opposite direction. The higher energy and sodium levels in added/removed vs. unchanged items implies that restaurants were making menu changes either with an interest in nutrition or something else correlated with nutrition (e.g., entrées that are better targets for new product marketing may tend to be those higher in energy).

Existing research on public health nutrition policies that affect restaurants, most notably for menu labeling laws, examines whether individual dietary choices vary within a fixed set of menu offerings.[7-11, 50, 56, 57] The present study fills a gap in the literature by addressing how those menu offerings could change. Menu changes alter the set of available choices that individuals face, but research that describes the energy and nutrition changes of restaurant menu items within the context of menu labeling law is limited to one other study. Bruemmer et al. evaluated entrée changes for 37 restaurant brands in an on-site audit 6 and 18 months after a menu labeling law was implemented in King County, Washington, in spring 2009 and spring 2010.[58] They found significant but modest decreases in energy and sodium overall, with larger changes in sit-down (e.g., family style) restaurants. Our study uses a larger sample of restaurants, draws from web-based nutrition information rather than in-store menus, and evaluates changes one year later than Bruemmer et al., but finds less evidence of change.

Many factors affect dietary intake, and within restaurants, factors such as marketing, promotions, bundling, and pricing matter.[34] This study reports on the objective food environment in restaurants faced by individuals, as defined by the set of menu entrées available – a key component that has not been well documented and that can inform broader debates on the role of restaurants in obesity. This initial study of restaurant menu trends over one year, in combination with early evidence that menu labeling laws do not strongly influence diners' choices,[11, 50, 51] suggests that neither supply nor demand-side changes are moving at the speed or scale needed to match the urgent health needs that stem from the nation's obesity epidemic. In fact, Brownell argues that the food industry's "minor progress creates an impression of change while larger attempts to subvert the agenda carry on."[45] The current study provides evidence in support of the notion that while some healthy changes occurred over the course of a year, unhealthy changes continued as well. Overall, we find a pattern of one step forward, one step back.

This study has several limitations. It is observational and variables that may influence menu change cannot be randomized, although explanatory variables in the analysis attempt to adjust for key factors. The study describes the nature of change over one year, during which time the federal menu labeling law was the major policy shock, but it does not directly test the hypothesis that changes (or lack thereof) were attributable to the law for several reasons. Nearly all restaurant brands (97%) were subject to the federal law, so a meaningful control group was not available. Smaller restaurant chains, which are not subject to the law, are less likely to report nutrition data,[46] and those that do report data are likely to be non-representative (i.e., more nutrition-conscious) of the small restaurant industry in general. Differences seen over the study timeframe may reflect changes from restaurants that started labeling calories on menus, but compliance was not assessed and likely to be limited, since the law was still not formally implemented at the point of purchase as of 2012. The timeframe also does not capture changes that may have occurred in response to local menu labeling laws already implemented at the time of baseline data collection in spring 2010 (e.g., in Seattle/King County and New York City). Finally, we do not observe the counterfactual – i.e., the nature of change in the absence of a federal menu labeling law. Restaurant portion sizes for some item types increased over time between 1977 and 1996,[15] and if the unobserved trend between 2010 and 2011 would have been an increasingly unhealthy set of entrées, then the observed flat line trend may actually be characterized as a small public health win.

Additional limitations pertain to the available data. Nutrition information posted on restaurant websites may not match what is offered in restaurants (which could vary from location to location, or in a state/region), may be inaccurate due to variations in preparation,[31] and may not have been current at the time of data collection. The format of web-based nutrition information is not subject to regulation and thus not fully standardized. This study focused on changes in entrées, but trends in other item categories – e.g., sides, drinks, desserts – may differ. The small changes observed in one year could be a function of the short timeframe of data collection (restaurants may wait before changing menus, or need more time to test and roll out menu changes), and/or more substantial menu changes that happened prior to the start of the study (e.g., due to menu labeling laws already implemented in some local jurisdictions).

Balancing these limitations are several strengths. The data represent the largest and most diverse group of restaurants studied, not just fast food. Web-based nutrition information represents what might be considered the standard set of menu offerings across a restaurant brand, whereas studies using in-store nutrition information have limited generalizability due to variation across stores. Moreover, while small chains and independent restaurants are not represented, the vast majority of U.S. consumers are likely to have the frequented these specific restaurants in the past year – the same is not true of small brands with a limited geographic customer base.

Conclusion

Whether the restaurant industry was influenced by the presence of a federal menu labeling law or not, this snapshot of restaurant entrées over one year can inform the broader debate about the evolving food environment. The overall balance of energy and nutrition was largely unchanged over one year. Items that were removed were replaced by items similarly high in energy and sodium (and higher than unchanged items), on average. In general, the changes that occurred were marginal, and certainly not transformative; the latter is needed to make noticeable progress on public health nutrition goals. Thus while healthy makeovers to restaurant menus may give the appearance of change, simultaneous unhealthy additions counter this progress. Consequently, noticeable shifts in the overall food environment have yet to be seen. Stronger efforts are needed to substantially shift the set of menu choices facing restaurant diners in a healthier direction.

Tables and Figures

Table 2.1. Descriptive Statistics: Energy and Sodium by Time Period and Change Status

	Regular Menu		Children's Menu	
	Energy (kcal) Mean (SD) n	Sodium (mg) Mean (SD) n	Energy (kcal) Mean (SD) n	Sodium (mg) Mean (SD) n
By Time Period				
Baseline	670 (398)	1515 (1121)	462 (214)	951 (537)
	12843	12447	859	847
Follow-up	670 (397)	1500 (1111)	468 (219)	932 (511)
	13413	12941	935	916
By Change Status				
Unchanged [a]	632 (388)	1395 (1067)	478 (219)	952 (500)
	6596	6408	471	466
Removed	709 (406)	1642 (1162)	443 (205)	950 (581)
	6247	6039	388	381
Added	705 (402)	1603 (1143)	457 (217)	911 (522)
	6817	6533	464	450
Total				
	670 (397)	1507 (1116)	465 (216)	941 (524)
	26256	25388	1794	1763

[a] Unchanged items appear in both baseline and follow-up data sets; sample size shown represents only unique unchanged items

Table 2.2. Change across All Menu Items after One Year, Regular Menus

Dependent variable: Energy (n=26,256)	Model 1 - Unadjusted Coeff (SE)			Model 2 - Time-service interactions Coeff (SE)			Model 3 - Time-service interactions and restaurant characteristics [a] Coeff (SE)		
	Mean (OLS)	25th per-centile	75th per-centile	Mean (OLS)	25th per-centile	75th per-centile	Mean (OLS)	25th per-centile	75th per-centile
R-squared [b]	0.000	0.000	0.000	0.126	0.054	0.110	0.190	0.095	0.159
Change in follow-up time period items	0 (8)	7 (6)	0 (10)						
Interactions: Marginal effects of follow-up by service model [c]									
Follow-up - fast food (reference category)				15 (12)	0 (8)	21 (12)	18 (12)	4 (6)	20 (11)
Follow-up - take-out				23 (28)	-10 (8)	10 (30)	30 (26)	0 (7)	3 (10)
Follow-up - fast casual				7 (20)	13 (10)	7 (13)	10 (21)	26 (11)*	2 (10)
Follow-up - buffet				3 (3)	-1 (8)	7 (35)	-1 (3)	-5 (14)	0 (13)
Follow-up - family				-8 (12)	2 (10)	-28 (13)*	-7 (11)	-3 (8)	-14 (12)
Follow-up - upscale				-4 (38)	-2 (12)	25 (64)	-2 (39)	2 (15)	41 (74)

* p<0.05, ** p<0.01, *** p<0.001

[a] Adjusted for other restaurant characteristics: national outlet count (small (1-99), medium (100-999), large (1000+), meal period served (breakfast, lunch, and/or dinner), and cuisine.

[b] Psuedo r-squared for quantile regression models.

[c] Follow-up period and service model main effects included in regression with interactions but not shown.

Table 2.2. Change across All Menu Items after One Year, Regular Menus (cont.)

Dependent variable: Sodium (n=25,388)	Model 1 - Unadjusted Coeff (SE)			Model 2 - Time-service interactions Coeff (SE)			Model 3 - Time-service interactions and restaurant characteristics [a] Coeff (SE)		
	Mean (OLS)	25th percentile	75th percentile	Mean (OLS)	25th percentile	75th percentile	Mean (OLS)	25th percentile	75th percentile
R-squared [b]	0.000	0.000	0.000	0.047	0.032	0.047	0.115	0.072	0.112
Change in follow-up time period items	-15 (21)	0 (12)	-33 (19)						
Interactions: Marginal effects of follow-up by service model [c]									
Follow-up - fast food (reference category)				39 (29)	12 (17)	40 (32)	51 (30)	10 (14)	53 (19)**
Follow-up - take-out				70 (113)	22 (21)	20 (68)	89 (104)	-20 (17)	26 (37)
Follow-up - fast casual				-7 (38)	30 (32)	-20 (46)	3 (43)	10 (23)	5 (27)
Follow-up - buffet				11 (3)**	11 (17)	20 (73)	1 (7)	0 (12)	0 (42)
Follow-up - family				-50 (32)	25 (27)	-70 (34)*	-44 (29)	-11 (19)	-40 (29)
Follow-up - upscale				-4 (78)	62 (50)	-52 (114)	10 (83)	87 (72)	17 (131)

* p<0.05, ** p<0.01, *** p<0.001

[a] Adjusted for other restaurant characteristics: national outlet count (small (1-99), medium (100-999), large (1000+), meal period served (breakfast, lunch, and/or dinner), and cuisine.

[b] Psuedo r-squared for quantile regression models.

[c] Follow-up period and service model main effects included in regression with interactions but not shown.

Table 2.3. Added-Removed Item Comparison, Regular Menus

Dependent variable: Energy (n=13,064)	Model 1 - Unadjusted Coeff (SE)			Model 2 - Time-service interactions Coeff (SE)			Model 3 - Time-service interactions and restaurant characteristics [a] Coeff (SE)		
	Mean (OLS)	25th percentile	75th percentile	Mean (OLS)	25th percentile	75th percentile	Mean (OLS)	25th percentile	75th percentile
R-squared [b]	0.000	0.000	0.000	0.111	0.040	0.103	0.164	0.070	0.139
Difference in added items	-4 (16)	-2 (6)	-6 (13)						
Interactions: Marginal effects of added item by service model [c]									
Added item - fast food (reference category)				23 (24)	0 (13)	40 (23)	34 (24)	5 (11)	63 (20)**
Added item - take-out				41 (52)	-20 (9)*	26 (40)	54 (50)	-5 (11)	2 (13)
Added item - fast casual				14 (39)	18 (17)	20 (16)	16 (40)	22 (15)	0 (15)
Added item - buffet				-19 (20)	-51 (51)	12 (92)	-20 (20)	-50 (50)	1 (89)
Added item - family				-18 (23)	0 (15)	-49 (19)*	-11 (22)	-2 (11)	-21 (16)
Added item - upscale				-15 (57)	14 (19)	38 (66)	-14 (57)	18 (19)	87 (82)

* p<0.05, ** p<0.01, *** p<0.001

[a] Adjusted for other restaurant characteristics: national outlet count (small (1-99), medium (100-999), large (1000+), meal period served (breakfast, lunch, and/or dinner), and cuisine.

[b] Psuedo r-squared for quantile regression models.

[c] Added item and service model main effects included in regression with interactions but not shown.

Table 2.3. Added-Removed Item Comparison, Regular Menus (cont.)

Dependent variable: Sodium (n=12,572)	Model 1 - Unadjusted Coeff (SE)			Model 2 - Time-service interactions Coeff (SE)			Model 3 - Time-service interactions and restaurant characteristics [a] Coeff (SE)		
	Mean (OLS)	25th per-centile	75th per-centile	Mean (OLS)	25th per-centile	75th per-centile	Mean (OLS)	25th per-centile	75th per-centile
R-squared [b]	0.000	0.000	0.001	0.037	0.026	0.047	0.105	0.056	0.100
Difference in added items	-39 (41)	-10 (20)	-70 (32)*						
Interactions: Marginal effects of added item by service model [c]									
Added item - fast food (reference category)				48 (60)	20 (38)	82 (46)	106 (61)	37 (31)	140 (57)*
Added item - take-out				115 (195)	-96 (30)**	2 (77)	148 (182)	-43 (26)	30 (39)
Added item - fast casual				-16 (73)	-2 (24)	-20 (55)	3 (85)	17 (27)	0 (50)
Added item - buffet				-79 (44)	-9 (115)	-680 (526)	-52 (38)	-66 (107)	-672 (542)
Added item - family				-103 (63)	-11 (33)	-144 (48)**	-82 (57)	-33 (25)	-90 (44)*
Added item - upscale				-15 (126)	49 (64)	-129 (162)	-1 (124)	138 (77)	-61 (219)

* p<0.05, ** p<0.01, *** p<0.001

[a] Adjusted for other restaurant characteristics: national outlet count (small (1-99), medium (100-999), large (1000+), meal period served (breakfast, lunch, and/or dinner), and cuisine.

[b] Psuedo r-squared for quantile regression models.

[c] Added item and service model main effects included in regression with interactions but not shown.

Table 2.4. Summary of Tests for Significant Changes within in Each Restaurant

Regular Menu

Summary of Fisher's Exact tests for each restaurant	Unhealthy change - # (%) restaurants with a significant decrease at p<0.05	Healthy change - # (%) restaurants with a significant increase at p<0.05	No change - # (%) restaurants with no significant change at p<0.05	# tests
Proportion of items <= 750 kcal at follow-up vs. baseline [a]	10 (0.05)	9 (0.04)	194 (0.91)	213
Proportion of items <= 750 kcal in added vs. removed items [a,b]	12 (0.07)	10 (0.06)	139 (0.86)	161
Proportion of items < 1000 mg sodium at follow-up vs. baseline [a,b]	4 (0.02)	12 (0.06)	189 (0.92)	205
Proportion of items < 1000 mg sodium in added vs. removed items [a,b]	7 (0.04)	13 (0.08)	136 (0.87)	156
Summary of one-sided t-tests for each restaurant	**Unhealthy change - # (%) restaurants with a significant increase at p<0.05**	**Healthy change - # (%) restaurants with a significant decrease at p<0.05**	**No change - # (%) restaurants with no significant change at p<0.05**	**# tests**
Mean energy at follow-up vs. baseline	15 (0.07)	21 (0.1)	177 (0.83)	213
Mean difference (kcal), among restaurants with significant change	186	-188		
Mean energy in added vs. removed items [b]	15 (0.09)	25 (0.16)	121 (0.75)	161
Mean difference (kcal), among restaurants with significant change	226	-239		
Mean sodium at follow-up vs. baseline [b]	8 (0.04)	17 (0.08)	180 (0.88)	205
Mean difference (mg), among restaurants with significant change	541	-615		
Mean sodium in added vs. removed items [b]	11 (0.07)	26 (0.17)	119 (0.76)	156
Mean difference (mg), among restaurants with significant change	547	-707		

[a] Healthy Dining criteria include a limit of 750 kcal and 2,000 mg sodium per entrée. A 1,000 mg sodium threshold was used instead, since 2,000 mg sodium exceeds the U.S. Department of Agriculture daily recommended upper limit for many adults.

Table 2.4. Summary of Tests for Significant Changes within in Each Restaurant (cont.)

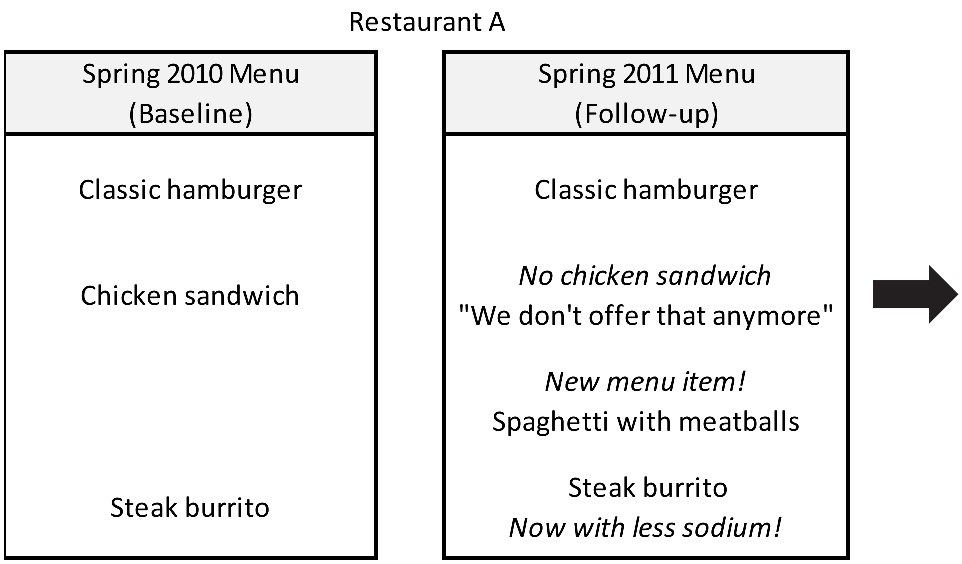
Children's Menu

Summary of one-sided t-tests of means for each restaurant	Unhealthy change - # (%) restaurants with a significant increase	Healthy change - # (%) restaurants with a significant decrease	No change - # (%) restaurants with no significant change	# tests
Mean energy at follow-up vs. baseline	1 (0.01)	1 (0.01)	107 (0.98)	109
Mean difference (kcal), among restaurants with significant change	234	-180		
Mean energy in added vs. removed items [b]	4 (0.05)	2 (0.03)	72 (0.92)	78
Mean difference (kcal), among restaurants with significant change	206	-165		
Mean sodium at follow-up vs. baseline [b]	2 (0.02)	2 (0.02)	103 (0.96)	107
Mean difference (mg), among restaurants with significant change	637	-357		
Mean sodium in added vs. removed items [b]	3 (0.04)	2 (0.03)	71 (0.93)	76
Mean difference (mg), among restaurants with significant change	674	-357		

The Kids LiveWell program was not yet established at the time of data collection, so the parallel analysis with regular menu items does not appear for the children’s menu analysis.

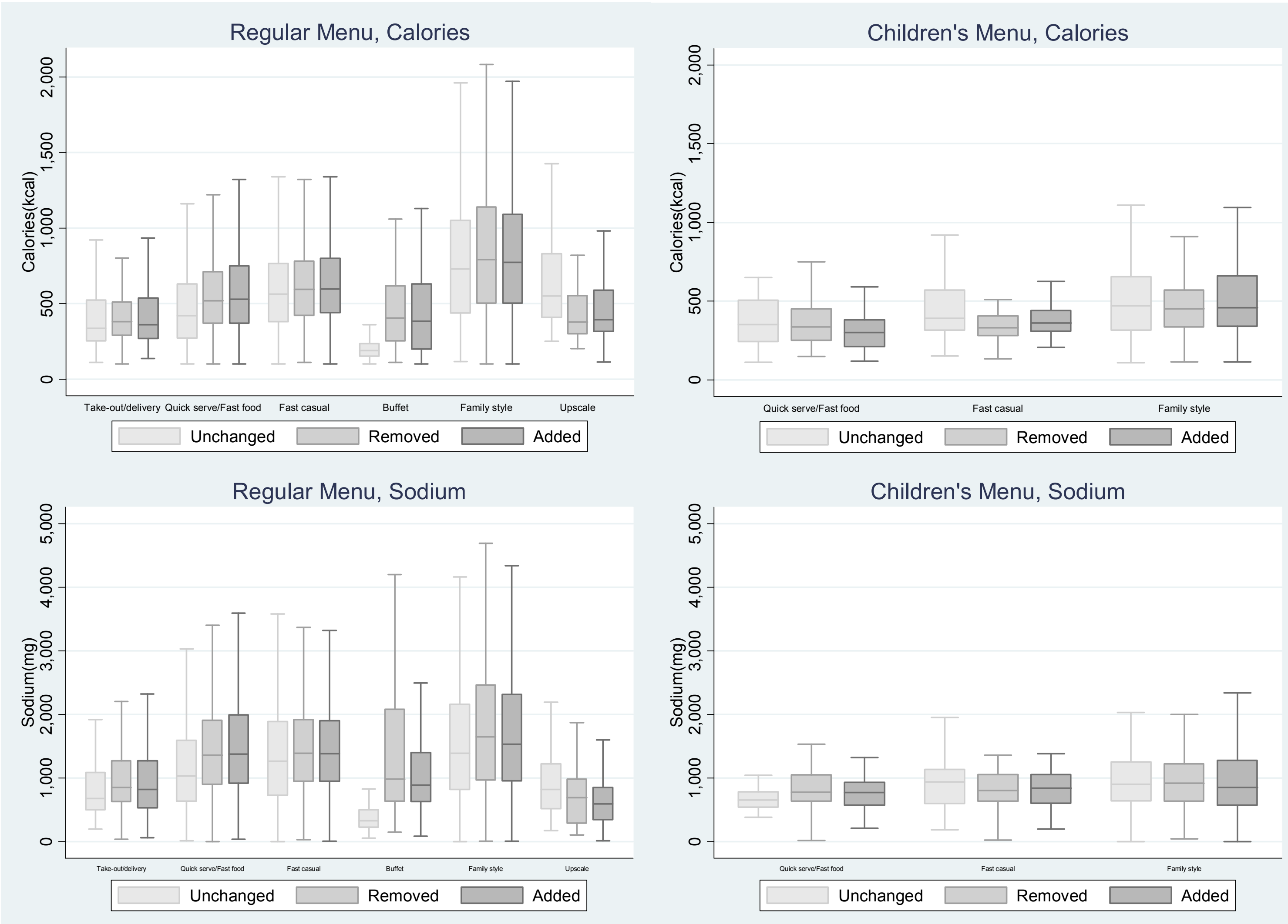
[b] Denominator is reduced in these measures and includes only those restaurants that had added/removed items, and/or that reported sodium, respectively.

Figure 2.1. Example of Item-Level Categorization



Item	Category
Classic hamburger	Unchanged
Chicken sandwich	Removed
Spaghetti with meatballs	Added
Steak burrito	Removed
Steak burrito - reduced sodium	Added

Figure 2.2. Boxplots of Energy and Sodium Levels, by Service Model and Change Category



Take-out/delivery, buffet, and upscale service models not shown for children's menu items; sample sizes in these sub-groups were very small.

Essay 3. Opportunities to Meet Nutrition Guidelines through Changes in Sodium Intake and Sodium Density from Restaurant Foods

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Abstract

Background. Dietary intake of sodium in the United States exceeds recommended levels for males and females of all ages. Restaurants play an increasing role in the U.S. diet, and changes to the sodium content of restaurant meals are one way to reduce population sodium intake. Changes across the food environment are needed to address the various sources of excess sodium, but the conditions under which changes to restaurant meal intake alone could be sufficient to achieve public health goals for sodium intake provide a reference point for understanding the potential impact of restaurant-focused interventions. Information about variation in the sodium density of restaurant menu offerings indicates the immediate targets for change.

Methods. A scenario analysis approach was used to illustrate the reduction in fast food restaurant intake that would be needed to achieve USDA recommended upper limits, assuming that none of the sodium intake achieved was replaced. Data were drawn from a prior study that documented the nutrition content of more than 30,000 major chain restaurant menu items in 2010, and additional parameters were taken from the literature. Sodium density (mg sodium per 1000 kcal) was evaluated with descriptive statistics.

Results. Sodium intake is so high on average that at many ages and for both genders, but especially males, eliminating restaurant meals completely would not be sufficient to bring intake within recommended upper limits. This is especially true for infrequent restaurant diners; frequent restaurant diners have more opportunity to bring dietary sodium intake within

recommended upper limits, under the model assumptions. Some age-gender groups, particularly children and adult/adolescent females, could bring intake with recommended upper limits, but they would need to substantially reduce sodium intake from restaurant meals. Restaurant foods are very sodium dense, and there is much room to reduce the amount of salt used. Very few main entrées exist that would allow consumers to eat at restaurants and stay within daily recommended upper limits.

Discussion. Current voluntary salt reduction goals for the restaurant industry are too low to bring sodium intake within recommended upper limits, based on restaurant changes alone. The imperative for sweeping change in the food environment beyond restaurants is clear, but there is much room for improvement in restaurant menu offerings. A huge gap exists between the excessively high sodium density of restaurant foods available to consumers and what individuals should be eating in order to stay within daily recommended upper limits. The restaurant industry should share a larger responsibility in this effort by preparing foods with less salt by default, since it can be added, but not taken away.

Introduction

Much attention has focused on how many individuals in the U.S. consume more energy and saturated fat than recommended. However, excess salt intake is far more prevalent. Nearly everyone consumes more sodium than the U.S. Department of Agriculture (USDA) recommends as a safe upper limit. Specifically, 99% of individuals with a recommended upper limit of 1,500 mg/day and 88% with a recommended upper limit of 2,300 mg/day consume more than the recommended amount.[(59)] Moreover, within virtually every age, gender, income, and racial/ethnic group, average daily sodium intake exceeds recommended upper limits.[(60-62)] Excessive sodium intake is particularly dangerous for individuals with chronic kidney disease, diabetes, and hypertension, as well as blacks and those 50 and older.[(20)] Studies estimate that high sodium intake accounts for more than 100,000 deaths annually,[(63)] and that at least 80% of individuals will develop hypertension at some point in their lifetime.[(64)]

Restaurants could be key players in the effort to lower population sodium intake, since consuming food away from home (FAFH)[iii] plays an increasing role in U.S. diet,[(2)] with the relative share of energy intake from fast food (FF) rising more than from other FAFH sources, for both children and adults.[(29, 66)] Although the amount of salt added at the table and used in cooking has not increased, sodium intake from processed foods and restaurant meals has increased.[(20)] Data from a USDA survey of food consumption found that the sodium density (mg/1000 kcal) of FF and family style (i.e., sit-down/table service) restaurant meals is higher

[iii] FAFH is a measure commonly used in federal dietary surveys, and many reports from these data use only the broad categories of FAFH vs. non-FAFH. FAFH includes foods consumed in restaurants, bars, stadiums, movie theaters, schools, vending machines, and other settings. The majority of FAFH energy is from fast food and sit-down restaurants (64% in 2003-2006),[(65)] but a substantial portion of FAFH refers to other sources.

than foods consumed at home,[29] and data from a review of restaurant nutrition showed that 74-87% of main entrées alone exceeds one-third of the USDA's daily recommended upper limits for adults.[46] FF intake is associated with lower dietary quality, including higher overall sodium intake.[67, 68]

Public health efforts to improve the food environment must adopt a broad view of all the sources of excessive sodium intake. The Institute of Medicine (IOM) called upon both food manufacturers and restaurant/foodservice operators to make their foods less salty, and for the Food and Drug Administration (FDA) to set mandatory national standards around the sodium content of foods.[69] Within the restaurant industry, these calls were met with resistance from many and cooperation from few. The value of fighting this public health battle in the restaurant industry, as opposed to directing more effort to food manufacturers, will depend on the extent to which restaurant meal changes can effectively bring population sodium intake within recommended upper limits.

This study focuses on sodium reduction through FF restaurant meals, with the goal of illustrating scenarios under which decreasing restaurant-based sodium intake alone could bring overall dietary intake within recommended upper limits. An understanding of the extent to which sodium density, defined as mg sodium per 1000 kcal in this study, can vary in restaurant foods provides insight into where those changes should happen first. Research questions are: 1) within each age-gender group, how much would sodium need to decrease in each restaurant meal in order to bring the respective group's daily sodium intake within recommended upper limits, 2) for which age-gender groups would changes in restaurant meals alone be insufficient to bring daily sodium intake within recommended upper limits, and 3) how does sodium density vary by restaurant service model, cuisine, and item type (i.e., where are the saltiest foods found)? The findings provide a starting point for policymakers to understand the potential impact of restaurant-focused interventions on population sodium intake, and they provide detail about targets for consumers and the restaurant industry to reduce sodium.

Methods

This study used 2010 data from 237 major U.S. chain restaurants that reported sodium for a total of 12,943 entrées and 2,979 sides for regular menus and 915 entrées and 213 sides for children's menus (Table 1.3). The data collection and data entry methodology are described elsewhere.[46] To address research questions 1 and 2, a scenario analysis approach was used to model a series of equations and illustrate a range of possible outcomes, which were implemented in Microsoft Excel 2010. To address research question 3, descriptive statistics were produced using Stata/IC version 10.1. Research questions 1 and 2 used the following model of sodium intake:

First, note that:

$$(1)\ FF\ intake\ per\ day = \frac{Intake\ per\ FF\ meal \times \#\ FF\ meals\ per\ week}{7}$$

Where:

Intake per FF meal = 1948 mg sodium for regular and 1186 for children's meals, based on one entrée and one side. Data use mean values in FF restaurant items derived from Essay 1.

 # FF meals per week ranges from 1 to 8, a distribution based on National Health and Nutrition Examination Survey (NHANES) data, which report that 49% of the U.S. population

has 1-7 meals prepared away from home each week, 12% has 8 or more, and 18% has less than one (not represented). Extrapolating beyond 8 meals per week yielded some implausible scenarios in which *FF intake per day* exceeded total sodium intake per day from all sources, given the parameters of the model.[1]

Second, note that:

$$(2) Excess\ intake\ per\ day\ =\ Actual\ intake\ per\ day - Recommended\ daily\ upper\ limit$$

Where:

Actual intake per day was evaluated at the mean and 95% upper and lower confidence limits (to account for within-group variation), based on values reported for 9 age groups as defined in 2009-2010 NHANES data.[60] Excess intake was always greater than zero; no age-gender group's *Actual intake per day,* even at the 95% lower confidence limit, was less than its respective *Recommended daily upper limits*. Although dietary intake includes both *FF intake* and non-FF/non-restaurant sources, the latter is held constant throughout this model in order to describe changes needed in *FF intake* alone.

Recommended daily upper limit is based upon age group-specific USDA recommended upper limits. A limit of 1,900 mg was used to approximate needs for ages 2-5 and 2,200 mg for ages 6-11, as USDA age groups do not exactly match those used by NHANES. A limit of 2,300 mg was used for ages 12-49, and 1,500 for ages 50 and older, but it should be noted that some individuals under 50 – those with chronic kidney disease, hypertension, diabetes, and African-Americans – also have a recommended upper limit of 1,500 mg. The model did not estimate values for these groups separately, so estimates of changes required to address excesses err on the conservative side.

When *FF intake per day* < *Excess intake per day*, as is the case for infrequent restaurant diners, then even eliminating all FF sodium intake would be insufficient to achieve the *Recommended daily upper limit* – e.g., one that consumes 500 mg too much sodium per day but only gets 100 mg of it from FF meals could hypothetically switch to zero sodium FF meals, or eliminate those FF meals altogether – but would still have to make changes to non-FF intake in order to achieve a 500 mg reduction. When *FF intake per day* > *Excess intake per day*, then some degree of change in FF intake could achieve the state of *Recommended daily upper limit*. The outcome *x* is defined as the percent change in *FF intake* of sodium needed to achieve the *Recommended daily upper limit*. A change of *x* could be achieved by reducing sodium in FF meals by *x*, reducing the amount of FF consumed by *x* (and replacing it with zero-sodium FF items or nothing at all), or a combination of the first and second strategies that equal *x*. The outcome *x* is defined by the following condition, which sets *Excess intake per day* equal to the needed change in FF intake per day:

$$(3)\ Excess\ intake\ per\ day = FF\ intake\ per\ day - FF\ intake\ per\ day\ (1 - x)$$

Which can be reduced to:

$$(4)\ x = \frac{Excess\ intake\ per\ day}{FF\ intake\ per\ day}$$

Where:

x = Percent change in sodium per FF meal needed to achieve the state *Actual Intake per day* = *Recommended daily upper limit*, evaluated at all values of *# FF meals per week*. In a scenario where one group's *Excess intake per day* = 250 mg sodium, for example, and *FF intake per day* = 500, then *x* = 0.5, i.e., a 50% reduction in daily FF intake would eliminate the 250 mg excess and bring this group down to its respective *Recommended daily upper limit*. The outcome *x* could be achieved through demand and/or supply-side changes – e.g., reducing sodium from FF meals could come from consumers ordering less salty foods or eating less overall, or from restaurants reducing the amount of salt used.

Example:

If a 20-29 year old female has 7 FF meals per week at 1948 mg sodium/meal, her mean *FF intake per day* under equation (1) is 1948 mg. Her *Actual intake per day* from all food sources is 3217 mg, on average (95% CI 3068, 3366). Since her *Recommended daily upper limit* is 2300 mg, under equation (2) her *Excess intake per day* is 917 mg (95% CI 768, 1066). She could eliminate this 917 mg *Excess intake per day* through reductions in her 1948 mg of *FF intake per day* alone, without making any changes to her intake from other sources.

Thus, the outcome *x* under equation (4) is:

$$x = \frac{Excess\ intake\ per\ day}{FF\ intake\ per\ day} = \frac{917}{1948} = 0.47$$

If the sodium in her *FF intake per day* (i.e., each FF meal) was reduced by 47%, this would be a decrease of 917 mg. That is the amount she needs to decrease *Excess intake per day* in order to achieve her *Recommended daily upper limit*. At the upper and lower 95% CI levels, $x = 0.39$ and 0.55. So we conclude that a 47% reduction (range, 39-55%) reduction of the sodium intake from FF meals, for a 20-29 year old female who has 7 FF meals per week, would bring her intake within recommended levels.

The model defines the outcome *x* in 9 age groups for both genders, based upon 8 values of the number of FF meals consumed per week. These characteristics generated 144 unique combinations of scenarios. Each group was represented once (i.e., no weighting was used), since this study uses a scenario analysis approach to illustrate a range of possible conditions, which is distinct from a population health impact assessment that aims to extrapolate to the number of individuals affected.

The hypothesized meal assumed the same ordering pattern for all: one main entrée and one side at the mean values of sodium for regular and children's menu entrées, respectively. These represent the largest sources of sodium in a restaurant meal, and beverages were excluded. Data used to form the study's hypothesized meal are similar in mean energy (851 kcal regular, 586 kcal children's) and sodium (1948 mg regular, 1186 mg children's) to levels found in other studies that measured meals ordered based on receipts. Studies in the New York City metropolitan area between 2007-2009 found that adult fast food meal purchases at major chains were between 823-847 kcal and 1751 mg sodium,[11, 35, 70] children up to 12 years had 519-575 kcal per meal,[50] and 71% of purchases were combinations of two or more items as opposed to single items.[35] Market research data report that fast food patrons order 1.7 food items on average, and that at the major FF restaurants McDonald's, Subway, Burger King, Wendy's, and Taco Bell, average sodium consumed per visit was 971-1,617 mg in children under 6 years and 1,561-2,231 mg in teens 13-17 years old (the latter group's hypothesized meal used regular menu values).[22] Those studies used a more limited sample of restaurant brands compared to the sample from which the current study's hypothesized meal values were derived, so the input values used in this study are based on a wider universe of FF menu offerings.

To address research question 3, descriptive statistics were produced to evaluate variation in sodium density for restaurant foods, with regular (i.e., non-children's) and children's menu items separately. Nutrient density is a common measure for describing the nutritional value of foods, standardized by the energy content. Numerous nutritional profiling measures are used in the literature, but there is no consensus on a single best measure of nutrient density.[71] USDA recommendations are based on the amount, not density of sodium intake, but nutrient density measures provide valuable information, in addition to nutrient content.[72] Sodium density was defined as mg/1,000 kcal, a common measure, so that results could be compared to historical USDA data and to findings discussed in the IOM report.[69] Results show the sodium density by item type and by key restaurant characteristics (service model and cuisine). Variation in sodium density based on service model and cuisine depends on the mixture of item types, so analyses also show sodium density excluding types that are generally non-savory (specialty drinks and desserts/baked goods). Also, a separate analysis of main entrées only was conducted to show differences in the mean and distribution of sodium density, using descriptive statistics and boxplots.

Results

Scenario Analysis

For some group scenarios, it is possible to bring sodium intake within recommended upper limits through reductions in FF intake alone. These opportunities exist mostly in children and female groups, but not male adolescent and adult groups, although a substantial degree of change is generally needed in the former. Figure 3.1 illustrates scenarios under which changes in FF intake alone would be sufficient or insufficient to bring intake within recommended upper limits. Values used in the model and the corresponding values of x, the change in FF intake needed to achieve the *Recommended daily upper limit*, are shown in Table 3.1. These results show that opportunity is greatest in frequent restaurant diners, given the larger share of FF intake to their diet under the model assumptions. Under the model assumptions that adults/adolescents consume the same FF meal, on average, Figure 3.1 shows that within the same age-gender group, those who dine out less frequently would need to make bigger changes at each restaurant meal than those who dine out more frequently (this finding would differ if those who dine out less frequently have higher-sodium meals than frequent diners). Practically speaking, requiring a very large change (e.g., of more than ~50% reduction in sodium) could imply consumers are served an unpalatable item or that they eat only a small fraction of a meal, which may be unrealistic. It could also require restaurants to make adaptations based on reduced shelf life.

Although it is mathematically possible under the model assumptions to bring intake within recommended upper limits for a number of groups, it is most feasible in those groups who require the smallest percentage changes in sodium intake. Based on dietary changes only within FF meals, which are the focus of the model, the magnitude of change needed could be achieved by reducing sodium in FF meals (e.g., restaurants reducing sodium content or consumers selecting lower sodium menu items), or by reducing overall intake from FF meals (and replacing it with zero sodium FF meals or nothing). A combination of these strategies could be the most feasible way to achieve the level of change required – e.g., getting a burger that is made with less added sodium and not ordering fries.

All those who consume only 1-2 FF meals per week would need to make changes beyond FF intake alone. NHANES reports that 9% of males and 12% of females consumed 1-2 meals prepared away from home per week, although this includes sources other than FF restaurants.[1]

Most adolescent and adult males who consume 3-7 FF meals per week would also need to make changes beyond FF intake. NHANES reports that 40% of males and 34% of females consumed 3-7 meals prepared away from home per week.[1] Many adolescent and adult female groups, as well as children of both genders, could bring intake within recommended limits through changes in FF intake alone, however, with as little as a 32% reduction in sodium intake from this source, or as much as a 98% reduction. The group corresponding to 8 FF meals per week represents up to the 16% of males and 8% of females in the U.S. who report having 8 or more meals prepared away from home per week,[1] and recommended upper intake levels could be met at this FF meal frequency with as little as a 28% reduction in sodium intake from this source, or as much as a 93% reduction.

Individuals 50 and older have a lower recommended upper limit (1500 mg), and larger scale changes are needed in these groups to meet the recommendations. Although results for high-risk individuals under 50 are not shown (e.g., those with diabetes, hypertension, chronic kidney disease, and blacks), it is clear that a large amount of change in FF sodium intake would be needed for all those with the recommended upper limit of 1500 mg – at least a 49% reduction from this source, based on the result for females 70 and older. NHANES estimates that 48% of the U.S. population overall, including 16% of those aged 2-17, and 31% of those aged 18-50, are subject to the 1500 mg/day limit.[59]

Sodium Density

Sodium density varies widely by restaurant characteristics and item type, as shown in Table 3.2, and it is high overall. The average sodium density across all regular menu items is 2196. In a

2000 kcal/day diet, consuming items at this average level would translate to an intake of 4392 mg sodium/day, far in excess of even the 2300 upper limit. Buffet restaurants' items are consistently the highest in sodium density, for regular and children's menus. Upscale restaurants' items are lower in sodium density, although this sample is small and probably biased, as most upscale restaurants did not report nutrition data (88%, Table 1.2). More non-savory items may have been among the menu offerings for take-out/delivery, FF, burger, and snack-style restaurants, since sodium density for these restaurant types was much higher when drinks and desserts/baked goods were excluded. FF restaurant items are actually more sodium dense than those in family style restaurants with this exclusion, even though entrées in the latter group have significantly higher sodium content (Table 1.4) (this may be due to larger portion sizes in family style restaurant entrées). Items from fast casual restaurants (e.g., Au Bon Pain), which may be perceived as being healthier than FF, are not so on the basis of sodium density. By cuisine, pizza and burger restaurants' items are among the lowest in sodium density, although these foods are often viewed as the least healthy. Sandwich, Asian, and chicken restaurants' items were commonly among the highest in sodium density, as were snack restaurants' items (after excluding the non-savory items).

Items with the highest sodium density should be the first targets in consumer or industry efforts to reduce overly salty foods. The specialty, non-alcoholic drinks represented in the data are higher in sodium density than might be expected for a category of items that is generally sweet. At a sodium density of 592 mg/1000 kcal, one 500 kcal specialty drink would supply 296 mg sodium, which is 20% of the daily upper limit at the 1500 mg level. Among the item types that are generally non-savory, soups stand out as being twice as sodium dense as most other item types. At a sodium density of 5723 mg/1000 kcal, one 250 kcal serving of soup would supply 1431 mg sodium, which approaches the daily recommended upper limit of 1500 mg. In general, sodium density was lower for children's menu items than the corresponding regular menu one, except for soup, although this was a small sample (n=9) on children's menus. Regular menu salads do not appear to be much better than main entrées, based on their similar sodium density. Salad dressings with low energy content (e.g., low-fat ones) would be more sodium dense than higher-fat dressings, and this category is very sodium dense overall. Cutting appetizers and sides from meals would eliminate two of the saltier item types, compared to entrées.

Analysis of entrées only finds further evidence that it is nearly impossible for one to stay within recommended upper limits after eating a restaurant meal (Table 3.3). The average sodium density across all regular menu entrées is 2378. In a 2000 kcal/day diet, consuming items at this level would result in an intake of 4756 mg sodium a day, more than twice than the 2300 mg recommended upper limit. Having just a 600 kcal main entrée at this sodium density would translate into 1427 mg sodium, which is nearly the daily limit at the 1500 mg level. This implies that anyone trying to meet the 1500 mg limit could probably not do so while meeting their energy needs, at the current saltiness levels of restaurant foods. Table 3.3 further supports findings that FF restaurant foods are saltier than those in family style restaurants. In a 600 kcal main entrée, an average FF entrée has 118 mg more sodium than the average entrée across all restaurants, whereas family style restaurants has 51 mg less – although the latter does supply more total sodium,[46] presumably due to larger portions.

Boxplots show the large range of sodium density for entrées across restaurant types (Figure 3.2). Items below a sodium density of 750 or 1115 would be in line with a 1500 or 2300 recommended upper limit based on a 2000 kcal diet, respectively, but relatively few items fall beneath those reference lines. The large range and heavy concentration of entrées above the reference lines show that there are many ways for consumers to choose poorly in any type of restaurant, but only a few ways to choose well. Asian restaurants' entrées are more problematic than other cuisines for both regular and children's menus, since they have a larger share of saltier items. Buffets' entrées are less sodium dense than many other service models in this analysis, but since consumers typically select many non-entrée item types there, buffets should still be considered a key target for sodium reduction due to the high average sodium density across all their items.

Discussion

There is an enormous gap between the salt-heavy nature of most restaurant foods and what people need to eat to stay within USDA guidelines, and major reductions in sodium intake are needed for all ages and genders. Within restaurant intake, these changes can come both from the demand side (consumers choosing lower sodium foods, eating smaller portions, ordering fewer items, or going out to eat less often), and the supply side (restaurants reducing salt use or portion size). Yet changes in restaurant dining alone will probably not be enough for those with substantial excess salt intake, such as men, while others would need to make very large reductions.

Sodium reduction has more immediate health benefits for older and other high-risk individuals, but it is important at younger ages as well. The rationale for establishing upper limits on sodium for younger and lower-risk groups is that hypertension is a progressive condition that builds over time, and the taste for salty foods builds over time,[69] so moderation even early in life is valuable. Also, pre-high blood pressure and high blood pressure are now appearing earlier in life, particularly among children and adolescents who consume too much salt.[73]

This study contributes to the literature by reframing data in a way that paints a picture of just how severe the excess sodium intake problem is, and by showing how drastic and widespread food and restaurant industry reductions in sodium need to be. Other studies have projected the effects of population sodium reductions on mortality, disease prevalence, and health care costs.[41, 74] This study takes a novel approach by applying scenario analysis to highlight ranges of possibilities across every age-gender group. Given variations and uncertainties in model parameters, such as how often people eat out, scenario analysis illustrates whether conclusions are sensitive to assumptions. It shows what findings are robust across different parameters – e.g., that conclusions about men hold no matter how frequently they eat out, and that even dietary intake variation within age-gender group (based on 95% confidence intervals) does not change the overall message.

Overall, the scenario analysis finds that changes well beyond FF restaurant intake alone are needed to achieve public health goals for men, and that individuals 50 and older will require bigger changes than their younger counterparts who eat out at the same frequency. The lack of opportunity to achieve sodium goals in men is related to their higher overall food consumption and energy needs; disparities in sodium intake by gender and age groups are explained largely by energy intake.[69] Since USDA standards are not adjusted based on energy needs in adults and adolescents, those with higher energy intake will end up consuming more salt unless they select less salty foods, but this does not happen – dietary sodium density is similar across adult age-gender groups,[69] even though average energy needs decrease with age. Excess sodium intake in the U.S. population is not explained entirely by excess energy intake, however, since at least 95% of adults exceed their respective recommended upper limits for sodium,[59] but fewer (74%) are overweight or obese.[75] Sodium dense food is itself a problem.

This study presents new data on the sodium density of what we eat, drawing from the largest known study to date of U.S. chain restaurant menu nutrition. The USDA Food and Nutrient Database for Dietary Studies used to estimate dietary intake for NHANES contains about 7,000 food items from all sources.[76] In comparison, this study uses data based on more than 30,000 items from restaurants alone (which include a total of 17,050 regular and children's menu main entrées and sides). This study demonstrates that the sodium density of restaurant menu offerings (2196 regular, 1865 children's) is higher than that in overall dietary intake (1443-1649 in NHANES 2003-2006 data, depending on age group[69]), adding to the evidence that restaurant dining contributes to excessive sodium intake.[29, 67, 68] Although averages based on the set of menu offerings available are different than what consumers eat, the difference may not be so large. The sodium density of FF menu offerings in the current study (2019) is similar to that reported in a 2007 New York City study of 6,580 FF lunches purchased (2136).[70] NHANES 2003-2006 data for sodium density of food consumed in restaurants (1805-1925) and for all away from home sources (1825) are lower than sodium density in the current study,[69] which may be real differences in intake patterns, or signal some underestimation in the USDA's database of nutrient values.

The huge variability in sodium density is consistent with Dunford et al. who find that the average sodium content of the same item within a restaurant was often higher in the U.S. than in other countries.[(77)] Variation indicates where the immediate targets to reduce sodium use or intake lie. On the demand side, even without having sodium information readily available, consumers can try to select lower-sodium foods – by not ordering soups, appetizers, or sides with their entrées, and limiting trips to buffets and Asian restaurants. But, the enormous range of sodium density within even one type of restaurant, dearth of lower sodium entrées, and absence of sodium information at the point of purchase in restaurants makes this a bad gamble.

Individuals who want to keep their sodium intake within USDA guidelines have a personal role in making healthier choices, but the food industry – both restaurants and food manufacturers – shares a responsibility for providing healthy options, because it is difficult for individuals to meet current guidelines given the high sodium content across all food sources. The selection of lower salt items is poor, and the "regular" preparation of foods sets the standard for how our taste buds respond to salt. Individuals cannot easily reduce sodium intake (other than by reducing portions) when it is already present in processed and prepared foods (including restaurant meals and food purchased for home consumption), which 77% of dietary sodium is.[(78)] They also could not achieve the needed changes shown in Figure 3.1 and Table 3.1 simply by substituting FF meals for home-cooked meals, for example, because sodium intake from the latter is still quite high. The sodium density was 1728 for FF meals and 1644 for food consumed at home in a 1994-96 USDA survey.[29]

Despite the high sodium content of restaurant foods, restaurants should not be the sole target, because evidence shows that FAFH actually accounts for a similar, not disproportionate, share of dietary sodium and energy intake. The USDA data show a small difference in sodium density of FF meals and food consumed at home, but how this difference translates into overall dietary intake is a different issue. Recent data from NHANES show that people get the same percentage of their dietary sodium from FAFH, compared to energy. FAFH accounts for 33% of energy and 33% of sodium intake for all individuals 2 and older, and differences by age-gender groups do not exceed 3% (e.g., males aged 70 and older report 18% of energy but 21% of sodium from FAFH).[79] Thus, while sodium reductions in restaurant meals will help individuals lower their overall sodium intake, food industry-wide changes are clearly also needed.

Supply-side reductions in sodium content will help individuals who are motivated to meet USDA guidelines, as well as those who are not; motivation to reduce salt use is low in many individuals. A Food and Drug Administration (FDA) consumer survey found that 23% of people believed they should reduce their sodium intake but have not really tried, 6% were trying but not successfully, and 46% did not believe they needed to reduce their salt intake,[80] which is at odds with the fact that at least 95% of adults consume more salt than recommended.[59] The discrepancy could be due in part to lack of awareness or acceptance of the USDA sodium recommendations, but the widespread acceptance that heavily salted foods are "normal" could also be a factor.

The food industry sets the standard for how sensitive our taste buds are to salt, and it could lower that standard; preference for saltier foods can decrease over time as sodium use decreases.[81] When restaurants add excessive salt to their standard meal preparations, their customers cannot simply take it away, and big changes are needed from the supply side in order to make noticeable progress on public health goals for sodium intake. The restaurant industry may advertise its cooperation with voluntary salt reduction programs, but it is not enough. In a 2011 National Restaurant Association survey, a majority of nearly 1,800 chefs surveyed said that healthier kids' meals, smaller portion sizes, and lower sodium main entrées would be "hot trends" on 2012 menus.[82] In reality, Essay 2 shows that change across menu offerings does not match the level of visible activity around such changes. The IOM report adds that 40 years of salt reduction efforts have not been enough.[69]

With the sodium density findings in this and other studies, there should be no more debate on whether the set of foods available to consumers is just too high in sodium. The discussion that needs to move forward is how to accelerate change across the food environment, by both food manufacturers and restaurants. Clearly, changes in sodium from restaurant meals alone will be insufficient. While both demand and supply-side changes play a role, changes within the restaurant industry will need to be larger than what has been observed in order to make noticeable progress on public health goals. Voluntary initiatives and industry pledges to gradually reduce sodium in the food supply are a start, and small decreases across the board may be needed to minimize noticeable taste differences. A 20% reduction of sodium (the overall goal of the National Salt Reduction Initiative, which includes food manufacturers and restaurants[83]) in one regular/children's FF meal, as defined in this study, is not sufficient to bring intake within recommended upper limits for any of the age-gender groups in this study's model.[iv] But, it is a start, and coupled with bigger changes in foods from other sources, it could be enough. Large sodium reductions may reduce shelf life, however, and require the food industry to find ways to provide fresher foods more efficiently. Major changes are unlikely to happen without new regulatory mandates, if the past 40 years of industry pledges are a good indicator of the future.

This study uses a model with several key assumptions, and these come with limitations. Namely, the model: 1) includes a limited set of restaurant dining frequencies in FF restaurants only, 2) uses the same reference meal for adolescents/adults and children (respectively), 3) extrapolates across age-gender groups based on dietary intake reported by a limited sample of individuals (NHANES), and 4) takes the USDA recommendations at face value. With respect to the first and second limitations, a multitude of scenarios could also be hypothesized beyond those presented in this study. Restaurant ordering patterns vary, although the reference meal is representative of the energy and sodium levels in items ordered in other studies, as noted earlier. The model focused on FF given its major role in FAFH intake, but dining occurs in other types of restaurants too, where sodium intake can differ. Some individuals dine out very infrequently (less than once per week, on average), but the model did not represent them, as the outcome of interest is only relevant for regular restaurant diners. Some individuals dine out more frequently than the high frequency scenario included in this model.

[iv] The initiative's goals for restaurants is not based on an overall percentage reduction, so direct comparisons of the initiative and this study's outcomes are intended to provide a point of reference only.

With respect to the third limitation, the outcome measure of change needed in restaurant meals is sensitive to inaccurate estimates of sodium intake, which can arise from errors in dietary recall and in the USDA database used to calculate sodium content of foods. NHANES estimates sodium intake using the automated multiple pass method for dietary recall to identify the type and amount of foods consumed.[84] The method reduces but does not eliminate bias; females and overweight/obese individuals are more likely to under-report energy intake in NHANES than men and normal weight individuals,[85] and this under-reporting will carry over into estimates of sodium intake. Other studies that compared dietary recall methods with urinary sodium excretion found that dietary recall substantially underestimates sodium intake in elderly[86] and hypertensive[87] groups, and the IOM recommended expanding dietary surveillance methods to include urinary sodium measures.[69] Thus, as much change as this study calls for, it may still underestimate the magnitude of decreases needed.

Finally, the study takes the USDA recommendations at face value to draw conclusions about needed changes to the sodium content of restaurant foods. The scientific community has not universally accepted that the body of evidence linking high sodium intake to adverse health outcomes is consistent, even though the IOM and USDA's expert panels, evidence reviews, and stakeholder input processes strongly support the recommended upper limits.[69] Those believing that USDA's recommendations are too strict, or even unnecessary, would obviously not agree with the study conclusions. In spite of these limitations, the strength of the scenario analysis method is it points to general conclusions and trends that are robust across different values, so this study's overall conclusions are unlikely to change based on most of the limitations.

Conclusion

Across a wide range of dining scenarios, virtually everyone will benefit from changes in both restaurant and non-restaurant sodium intake. In fact, sweeping changes across the food environment are imperative to make progress towards public health sodium targets. It is not enough to call upon consumers to choose lower sodium foods, when very few restaurant menu offerings have a place in a sodium-conscious diet. People can enjoy lower-salt foods, given small changes across the food environment over time, but these changes cannot be stalled any longer. Restaurants can play an important role by helping to reset our taste buds to more reasonable sodium levels.

Tables and Figures

Table 3.1. Reductions in Sodium per Fast Food Meal Needed to Meet USDA Guidelines: Model Parameters

Age-gender group	Actual intake				Rec upper limit	Excess intake			# FF meals per week and corresponding FF intake per day 1 278	2 557	3 835	4 1113	5 1391	6 1670	7 1948	8 2226
Adolescent and adult	Mean	SE	95% CI, LL	95% CI, UL		MEAN	95% CI, LL	95% CI, UL	x, % change in FF intake per day to achieve recommended intake, at mean (95% CI LL, UL) [a]							
M 12-19	4211	157	3897	4525	2300	1911	1597	2225	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (0.96,>1)	0.98 (0.82,>1)	0.86 (0.72,1)
M 20-29	4376	112	4153	4599	2300	2076	1853	2299	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (0.95,>1)	0.93 (0.83,>1)
M 30-39	4533	105	4322	4744	2300	2233	2022	2444	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (0.91,>1)
M 40-49	4588	163	4263	4913	2300	2288	1963	2613	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (0.88,>1)
M 50-59	4253	152	3950	4556	1500	2753	2450	3056	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)
M 60-69	3900	80	3740	4060	1500	2400	2240	2560	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)
M 70+	3205	73	3060	3350	1500	1705	1560	1850	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (0.93,>1)	0.88 (0.8,0.95)	0.77 (0.7,0.83)
F 12-19	2958	96	2767	3149	2300	658	467	849	>1 (>1,>1)	>1 (0.84,>1)	0.79 (0.56,>1)	0.59 (0.42,0.76)	0.47 (0.34,0.61)	0.39 (0.28,0.51)	0.34 (0.24,0.44)	0.3 (0.21,0.38)
F 20-29	3217	74	3068	3366	2300	917	768	1066	>1 (>1,>1)	>1 (>1,>1)	>1 (0.92,>1)	0.82 (0.69,0.96)	0.66 (0.55,0.77)	0.55 (0.46,0.64)	0.47 (0.39,0.55)	0.41 (0.35,0.48)
F 30-39	3050	63	2924	3176	2300	750	624	876	>1 (>1,>1)	>1 (>1,>1)	0.9 (0.75,>1)	0.67 (0.56,0.79)	0.54 (0.45,0.63)	0.45 (0.37,0.52)	0.39 (0.32,0.45)	0.34 (0.28,0.39)
F 40-49	3014	74	2866	3162	2300	714	566	862	>1 (>1,>1)	>1 (>1,>1)	0.86 (0.68,>1)	0.64 (0.51,0.77)	0.51 (0.41,0.62)	0.43 (0.34,0.52)	0.37 (0.29,0.44)	0.32 (0.25,0.39)
F 50-59	2992	80	2832	3152	1500	1492	1332	1652	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (0.96,>1)	0.89 (0.8,0.99)	0.77 (0.68,0.85)	0.67 (0.6,0.74)
F 60-69	2891	79	2733	3049	1500	1391	1233	1549	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	1 (0.89,>1)	0.83 (0.74,0.93)	0.71 (0.63,0.8)	0.62 (0.55,0.7)
F 70+	2588	65	2457	2719	1500	1088	957	1219	>1 (>1,>1)	>1 (>1,>1)	>1 (>1,>1)	0.98 (0.86,>1)	0.78 (0.69,0.88)	0.65 (0.57,0.73)	0.56 (0.49,0.63)	0.49 (0.43,0.55)
	Actual intake				Rec upper limit	Excess intake			# FF meals per week and corresponding FF intake per day 1 169	2 339	3 508	4 678	5 847	6 1017	7 1186	8 1355
Child	Mean	SE	95% CI, LL	95% CI, UL		MEAN	95% CI, LL	95% CI, UL	x, % change in FF intake per day to achieve recommended intake, at mean (95% CI LL, UL) [a]							
M 2-5	2331	71	2190	2472	1900	431	290	572	>1 (>1,>1)	>1 (0.52,>1)	0.85 (0.35,0.69)	0.64 (0.26,0.51)	0.51 (0.21,0.41)	0.42 (0.17,0.34)	0.36 (0.15,0.29)	0.32 (0.13,0.26)
M 6-11	3062	62	2937	3187	2200	862	737	987	>1 (>1,>1)	>1 (>1,>1)	>1 (0.88,>1)	>1 (0.66,0.89)	>1 (0.53,0.71)	0.85 (0.44,0.59)	0.73 (0.38,0.51)	0.64 (0.33,0.44)
F 2-5	2283	57	2169	2397	1900	383	269	497	>1 (0.97,>1)	>1 (0.48,0.89)	0.75 (0.32,0.6)	0.57 (0.24,0.45)	0.45 (0.19,0.36)	0.38 (0.16,0.3)	0.32 (0.14,0.26)	0.28 (0.12,0.22)
F 6-11	2875	66	2743	3007	2200	675	543	807	>1 (>1,>1)	>1 (0.98,>1)	>1 (0.65,0.97)	1 (0.49,0.73)	0.8 (0.39,0.58)	0.66 (0.33,0.48)	0.57 (0.28,0.41)	0.5 (0.24,0.36)

[a] Values of >1 denote scenarios where even eliminating 100% of FF intake would not be sufficient to achieve recommended upper limit.
Color grades are based on values of < 0.40, .60, .80, and 1.
The best opportunities to bring intake within recommended upper limits are the darkest cells, with the smallest values of x, i.e., the smallest needed change.

Table 3.2. Variation in the Sodium Density of Menu Items

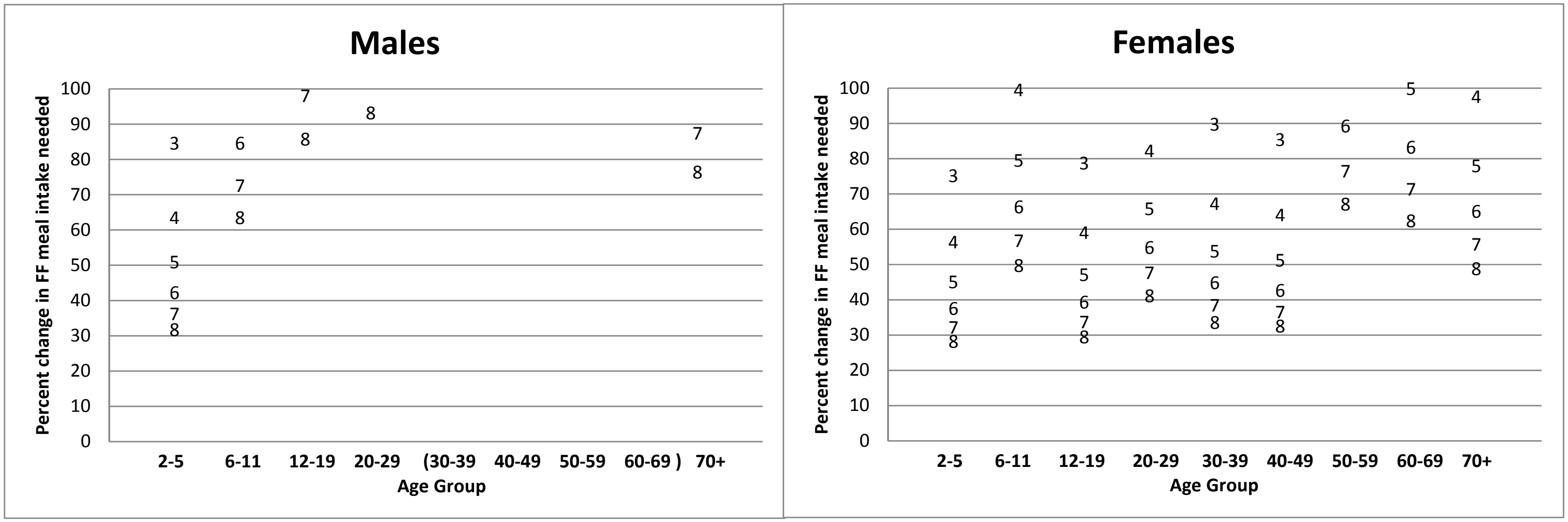
Sodium density (mg/1000 kcal)	Regular Menu				Children's Menu			
	All Item Types		Drinks & desserts excl.		All Item Types		Drinks & desserts excl.	
By service model	Mean (SE)	n	Mean (SE)	n	Mean (SE)	n	Mean (SE)	n
Take-out/delivery	1336 (33)	2687	2576 (70)	952	832 (94)	57	1686 (285)	13
Fast food	2019 (36)	6845	2905 (45)	4013	1765 (100)	140	2207 (96)	107
Fast casual	2493 (42)	5640	2886 (50)	4510	2313 (188)	185	2358 (192)	180
Buffet	2634 (75)	1466	3067 (93)	1130	2843 (601)	6	2843 (601)	6
Family style	2314 (25)	11759	2561 (27)	10232	1851 (47)	985	2071 (50)	849
Upscale	1620 (74)	296	1855 (78)	253	1497 (140)	7	1497 (140)	7
By cuisine type	Mean (SE)	n	Mean (SE)	n	Mean (SE)	n	Mean (SE)	n
American	2419 (32)	10294	2755 (38)	8413	1817 (54)	608	2040 (57)	518
Asian	2991 (79)	848	3068 (80)	820	2391 (296)	32	2445 (301)	31
Burger	1509 (34)	2569	2270 (50)	1483	1759 (120)	99	2079 (123)	80
Chicken	2794 (165)	526	3017 (178)	477	2594 (737)	16	2736 (773)	15
Italian	2272 (43)	1918	2378 (44)	1814	1857 (127)	153	1986 (133)	141
Mexican	2432 (33)	2411	2510 (33)	2314	2009 (68)	177	2096 (65)	167
Pizza	2228 (40)	1844	2266 (38)	1777	1876 (304)	44	2027 (324)	40
Sandwich	3112 (111)	1841	3244 (89)	1666	2205 (138)	73	2242 (139)	71
Snack	1203 (22)	4959	3120 (77)	1020	1430 (303)	111	2930 (729)	43
Steak & Seafood	2840 (78)	1483	3092 (85)	1306	2005 (237)	67	2364 (258)	56
By item type	Mean (SE)	n			Mean (SE)	n		
Main entrée	2378 (13)	12943			2178 (37)	915		
Appetizer	2648 (50)	1119			n/a	0		
Side	2650 (91)	2979			1686 (181)	213		
Salad	2298 (33)	1756			1817 (148)	15		
Salad dressing	4013 (227)	894			2750 (1185)	10		
Soup	5723 (86)	1399			6853 (1330)	9		
Specialty drink	592 (9)	3149			399 (27)	84		
Dessert/baked good	873 (35)	4454			530 (29)	134		
Overall	2196 (17)	28693	2715 (20)	21090	1865 (44)	1380	2124 (48)	1162

Table 3.3. Differences in the Sodium Density of Main Entrées and Sodium Equivalents

	Regular Menu			Children's Menu		
	Mean, sodium density	Difference from overall average, sodium density	Equivalent difference in sodium (mg), for a 600 kcal entrée	Mean	Difference from overall average, sodium density	Equivalent difference in sodium (mg), for a 450 kcal entrée
By service model						
Take-out/delivery	2384	6	4	2292	114	51
Fast food	2575	197	118	2295	117	53
Fast casual	2417	39	23	2272	94	42
Buffet	2255	-123	-74	2843	665	299
Family style	2293	-85	-51	2137	-41	-18
Upscale	1594	-784	-470	1497	-681	-306
By cuisine type						
American	2307	-71	-43	2135	-43	-19
Asian	2874	496	298	2807	629	283
Burger	2117	-261	-157	2160	-18	-8
Chicken	2708	330	198	2763	585	263
Italian	2139	-239	-143	1917	-261	-117
Mexican	2477	99	59	2145	-33	-15
Pizza	2183	-195	-117	2083	-95	-43
Sandwich	2673	295	177	2377	199	90
Snack	2450	72	43	2352	174	78
Steak & Seafood	2756	378	227	2434	256	115
Overall [a]	2378			2178		

[a] At the respective overall averages of sodium density, a 600 kcal regular menu entrée would have 1427 mg sodium, and a 450 kcal children's menu one would have 980 mg sodium. Calorie reference values are near the median levels of regular/children's menu entrées.

Figure 3.1. Opportunities to Meet USDA Guidelines, by Gender, Age Group and Number of Fast Food Meals Consumed per Week

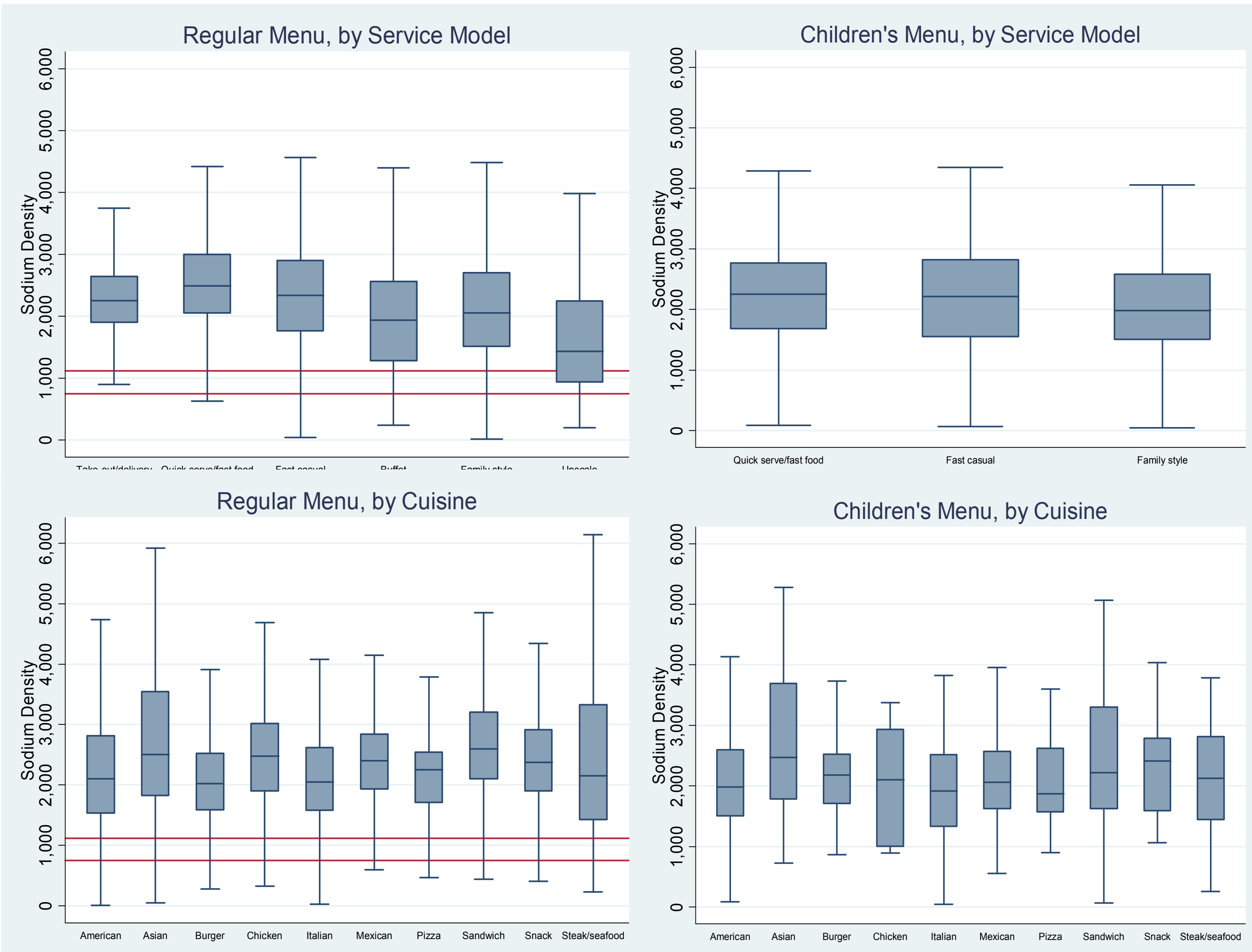


Numerical markers inside the graphs indicate the meal scenario represented (i.e., 1-8 FF meals per week), not the corresponding y-axis value.
For example, for males 20-29 that have 8 FF meals per week, a 93% reduction in FF meal intake would be needed to achieve the recommended upper limit.

Figure shows values of x based on mean levels of sodium intake. Values of x based on lower and upper 95% confidence interval levels of sodium intake are provided in Table 3.1 but not shown in this figure.

Scenarios where even eliminating 100% of FF intake would not be enough to achieve recommended upper limit correspond to values greater than 100, and do not appear in this figure (e.g., all scenarios for males 30-69, and all scenarios for individuals consuming 1-2 FF meals per week).

Figure 3.2. Boxplots of Sodium Density for Main Entrées, by Service Model and Cuisine



Take-out/delivery, buffet, and upscale service models not shown for children's menu items; sample sizes in these sub-groups were very small.
Reference lines in regular menu graphs are set at 1115 and 750, the average needed to stay within a 2300 and 1500 mg sodium/day in a 2000 kcal diet.

Conclusion

This dissertation explored the role of restaurants in the food environment, with a goal of informing policy efforts to address chronic diseases through better nutrition. Through a series of three essays that explored the topic from cross-sectional, longitudinal, and hypothetical perspectives, it generated new evidence to shed light on this increasingly important yet poorly understood component of the food environment.

Essay 1 established a baseline set of nutrition values across the landscape of major chain restaurants, and shed it light on opportunities for improvement which were previously unknown. It will allow researchers and policymakers to track restaurant-based food environment changes over time, including those that stem from public health efforts. It found much room for improvement in restaurant nutrition. Specific policy implications included:

- **Promises and pitfalls of menu labeling**. As an information transparency policy, menu labeling lifts a veil on restaurants that were previously less forthcoming with their web-based nutrition information. However, calorie labeling alone on restaurant menus may create a health halo, as many items that appear to have reasonable calorie levels have high levels of fat, saturated fat, and/or sodium.
- **Future policy targets.** The restaurant industry-supported Healthy Dining stamp used to denote healthier items is overly generous, especially for sodium. Additionally, the debate about the role of sugar-sweetened beverages in childhood obesity should spill into the restaurant setting, given the high energy content of specialty drinks on children's menus.

Finally, fast food restaurants are not the only meaningful target in policies to address unhealthy food environments; family style restaurants could be even more problematic.

Essay 2 provided a snapshot of change over the course of one year, finding only weak signals of shifts towards lower sodium in restaurant entrées. The overall lack of change should serve as a caution to policymakers that a lot of visible activity around healthy eating may be a distraction rather than a sign of progress, if the overall food environment remains unchanged. Specific policy implications included:

- **Longer-term evaluations.** Evidence does not suggest the presence of a new menu labeling law was effective in encouraging early changes to menus, but it also does not conclude it was ineffective. No increase in energy content of foods could be a public health "win" if the policy activity halted a trend that otherwise would have been increasing. Longer-term evaluations of the effect of menu labeling are needed to better understand how restaurants respond to such policies.
- **Small sodium reductions**. Limited signals of shifts to lower sodium in entrées could be a spillover effect of menu labeling, but it could reflect the success of other public health efforts. In the case of the former, even though restaurants were not required to add sodium to menus, forcing them to take a hard look at the nutrition of their menu items in anticipation of the menu labeling laws may have encouraged these small changes.

Essay 3 illustrated the magnitude of change that must be made by consumers and/or restaurants in order to meet nutrition recommendations for sodium. Any small improvement helps, but it provided a sobering picture that illustrated why small changes in fast food restaurant intake are not enough. It also illustrated the challenges and opportunities of overly salty foods in restaurants. Specific policy implications included:

- **Food environment-wide change**. Moderate changes in restaurants alone will help some individuals, but major changes to sodium used in all foods are needed to make noticeable progress towards public health sodium intake targets. Gradual reductions in industry salt use over the past 40 years have not been satisfactory, and our tolerance for such a slow rate of change should not be so high.
- **Role of restaurants.** The onus cannot be on the consumer to select less salty foods when such options are so scarce among menu offerings. Restaurants should use less salt by default and leave it to consumers to add more if desired. In doing so, they could help to reset our taste buds to a lower level of saltiness.

Successful public health and policy efforts to improve the food environment in restaurants may each have only a small effect. The journey of a hundred miles begins with a single step, and the value of incremental changes over time should not be dismissed. The public health wars on trans fat and tobacco only saw noticeable progress after decades of regulatory, advocacy, research, and education efforts. Likewise, a reshaping of the food environment will not happen overnight. However, to be satisfied with small wins would be complacent, given the tremendous scale and urgency of the problems at hand – epidemics of obesity and diabetes, and a health care delivery and financing system that is overwhelmed. Actions taken to improve the food environment must be swift and aggressive in order to rise to the level that these population health needs demand.

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Appendix A. Data Entry Protocol

The format of web-based nutrition information was not subject to any laws, and there was substantial variation in how restaurants reported it. A coding protocol was developed to maximize consistency in data entry. It was based on implementation guidelines for the California menu labeling law,[18] which was scheduled to go into effect at the time of baseline data entry and would have covered more restaurants than any other such in existence at its time (federal guidelines were not available at data entry). The main features of the data entry protocol were:

- Restaurants were counted as having complete nutrition information available if the calorie content was given for what appeared to be the majority of standard menu items. Information for sodium, total fat, saturated fat, trans fat, total carbohydrates, and protein were also reported when available. Data that were inconsistently reported (e.g., serving size, sugar, fiber, vitamins) were excluded. In a review of 50 restaurant menus from the final study population, for example, only 25 reported the weight or volume of a serving size. Conclusions about changes in serving sizes would be limited, and possibly biased, if variables such as this were reported.
- Menu items represented in website nutrition information were not compared to the actual menus used for ordering. The latter set was infrequently available on websites separately from nutrition information, and menu offerings vary across locations and regions. Any discrepancy between what is presented in nutrition information and what is offered in various restaurant locations is not reflected.
- Restaurants were classified as not having complete information if they: 1) did not offer a single standard preparation or nutritional analysis for a majority of menu items (e.g., menu

based fully on customized “build-your-own” combinations), 2) only provided information on what appeared to be a minority of the menu (e.g., “healthy choices” only), 3) did not provide information on the website nor provide web/e-mail contact information to request it, or 4) did not provide information on a website nor respond to an e-mail request for it.

- Data are reported per serving, based on the restaurant-determined number of servings per item, and entered as one serving if none was specified. This method, from the California law, is different than the federal law, which stipulates that energy should be presented for the item “as served,” not “per serving.” The practice of splitting items into smaller serving sizes could be a concern, but a review of 50 restaurant menus from the baseline study population found only one restaurant that appeared to split serving sizes to show data other than how the item was served (not counting family style items such as whole pizzas, which were always split into single-slice serving sizes). Although the study limitations note that results may be an artifice of serving size distortion, it was infrequent and overall results should not be noticeably affected.
- Sauces, add-ons/toppings, and condiments were only included in the item’s energy and nutrition count if included as part of the standard preparation.
- Every individual, unique item and size was coded as a separate observation, as each represents a distinct menu choice. If the same item was presented with customization options, the high and low energy values were coded as two separate menu items, with other customizations excluded. Catering platters and family size items were excluded unless individual serving portions were noted, in which data were entered for one serving.

- Items not typically designed for individual in-restaurant consumption were excluded (e.g., whole pies, loaves of bread, pre-packaged foods). Items on promotional, limited-time, daily/special, seasonal/holiday, happy hour, regional, and seniors’ menus were excluded.
- Items were classified as children’s menu items only if the restaurant specifically designated them as such. Regular menu items are all other items not listed as part of children’s menus.