Healthier Restaurant Environments as a Child Obesity Prevention Strategy

HEALTHIER RESTAURANT ENVIRONMENTS AS

A CHILD OBESITY PREVENTION STRATEGY

ALYSSA MORAN

A Dissertation Submitted to the Faculty of

The Harvard T.H. Chan School of Public Health

in Partial Fulfillment of the Requirements

for the Degree of Doctor of Science

in the Department of Nutrition

Harvard University

Boston, Massachusetts

May 2018

Dissertation Advisor: Dr. Eric Rimm Alyssa Moran

HEALTHIER RESTAURANT ENVIRONMENTS AS

A CHILD OBESITY PREVENTION STRATEGY

Abstract

Consumption of restaurant foods, including fast-foods and sugar-sweetened beverages (SSBs), has contributed to the rising global prevalence of obesity and related diseases among children and adolescents. The World Health Organization, U.N. International Children's Emergency Fund, and Centers for Disease Control and Prevention have recommended reducing consumption of restaurant foods as a key child obesity prevention strategy, and many localities have considered policies to improve the nutritional quality of restaurant foods marketed towards youth. Although it is clear that the restaurant environment influences youth food and beverage choices, more research is needed to identify how the industry can improve, which aspects of the environment have the greatest influence on choice, and how those factors may contribute to socioeconomic health inequities. This dissertation used data from three sources to better understand how the restaurant food environment has changed over time, to describe the influence of this environment on youth perceptions and choices, and to identify possible levers for policy change.

Chapter 1 described foods and beverages offered on kids' menus of 45 leading U.S. chain restaurants over four years, and evaluated the influence of a restaurant industry self-regulatory initiative, called Kids LiveWell, which sought to improve nutrition in meals advertised to kids. **Chapter 2** assessed adolescent estimates of sodium in fast-food meals, calculated actual sodium in meals purchased, and compared estimated to actual sodium. **Chapter 3** used data from the U.S. Department of Agriculture National Household Food Acquisition and

Purchase Survey -- a survey of foods and beverages acquired by a nationally representative sample of households -- to describe youth restaurant beverage purchases and differences by household socioeconomic status. Collectively, these data add to a growing body of evidence demonstrating a need for policies that improve the restaurant food environment by increasing the selection of healthful meals available to kids, increasing transparency about nutrition in restaurant foods, and reducing availability and promotions of SSBs, particularly those targeting youth in the lowest income households.

Table of Contents

Abstract………………………………………………………………………………... ii

List of Figures……………...…………………………………………………………...... v

List of Tables……………...…………………………………………………………..… vi

Acknowledgements……………………………………………………………………... vii

Chapter 1 Trends in Nutrient Content of Children's Menu Items in U.S. Chain Restaurants………………………………………………………………….. 1

Chapter 2 Consumer Underestimation of Sodium in Fast Food Restaurant Meals: Results from a Cross-Sectional Observational Study…………………………………… 26

Chapter 3 Child and Adolescent Beverage Purchases at the 76 Largest U.S. Chain Restaurants………………………………………………………………… 54

List of Figures

Figure 1.1 Types of children's beverages available in 45 U.S. chain restaurants in 2012-2015…………………………………………………………….……… 15

Figure 1.2 Types of children's sugar-sweetened beverages available in 45 U.S. chain restaurants in 2012-2015……………………………………………………..……. 16

Figure 2.1 Flow diagram of sampling selection and total number of adults and adolescents included in the analysis………………………………………………………… 34

Figure 2.2 Mean (SE) difference between actual and estimated calories (kcals) and sodium (mg) in meals purchased by a sample of adults and adolescents dining at fast-food restaurants……………………………………………………………………… 41

Figure 3.1 Sample selection flow chart…………………………………………………….. 63

Figure 3.2 Sugar-sweetened beverage, healthy beverage, and kids' beverage purchases at the 76 largest U.S. chain restaurants ……………………………………….…... 72

Figure 3.3 Per capita beverage calories (kcals) and sugar (g) by age and household income……………………………………………………………………….... 76

List of Tables

Table 1.1 Children's menu item characteristics in 45 U.S. chain restaurants in 2012-2015... 7

Table 1.2 Mean per-item nutrients in children's menu items in 2012 and changes from 2012 to 2015……………………………………………………………………….. 11

Table 1.3 Difference in mean per-item nutrients in children's menu items from 2012-2015 among U.S. chain restaurants participating in Kids LiveWell as of January 2015 and non-participating restaurants…………………………………………….. 12

Table 2.1 Characteristics of adults and adolescents purchasing meals form fast food restaurant chains in four cities in New England, US, 2013 and 2014, and responses to questionnaire items………………………………………….....… 37

Table 2.2 Characteristics of meals purchased at fast food restaurant chains in four cities in New England in 2013 and 2014 by adults and adolescents included in a study of consumers' estimates of sodium content of meals……………………………… 40

Table 2.3 Predictors of sodium estimation among adults and adolescents purchasing meals at fast food restaurant chains in four cities in New England, US, 2013 and 2014……………………………………………………………………...… 48

Table 3.1 Beverage coding…………………………………………………….…...… 61

Table 3.2 Characteristics of beverage purchases made for or by youth at the leading 76 U.S. chain restaurants in 2012-2013…………………………..……………...…… 65

Table 3.3 Odds and predicted probabilities of youth beverage purchases at the leading 76 U.S. chain restaurants in 2012-2013……………………...………………..… 68

Table 3.4 Correlates of mean beverage calories and sugar from youth beverage purchases at the leading 76 U.S. chain restaurants in 2012-2013……………………………. 74

Acknowledgments

I am deeply grateful for the support I have received throughout my life and during my four years at Harvard, without which this dissertation would not have been possible. To begin, I would like to thank my committee members, Drs. Eric Rimm, Sara Bleich, and Subu Subramanian for their mentorship and expert guidance. I have tremendous admiration for their contributions to public health and I am often in disbelief at my luck in having worked with them. They are models of great researchers who also happen to be three of the kindest people I have met. They have given me the skills, confidence, and academic freedom to begin to find my own voice, and for that, I am extremely grateful. I would also like to thank Drs. Christina Roberto, Jason Block, and Frank Sacks, who have shown me the utmost generosity. They have helped me to navigate a world that was completely unfamiliar just a few years ago, and in which, with their guidance, I have learned to grow and thrive.

There are many other staff, faculty, and students at Harvard and beyond who have guided me through my doctoral journey, and I am blessed to have so many to thank. I am forever indebted to Simo Goshev at IQSS for his enthusiasm, creativity, and patience. I would also like to thank Stef Dean, Patrice Brown, Amina Gueye, Bristian Justice, Man Tan, Tao Hou, Jill Arnold, and Aarohee Fulay for their positivity, diligence and seemingly magical abilities to keep me organized and stress-free. I am tremendously grateful for the generous funding from the National Institutes of Health, and the Pritzker, Simonian, Berkowitz, and Bloom families. Their gifts have allowed me to take advantage of the depth of knowledge at Harvard, encouraged me to take risks, and given me unbridled academic freedom. I must thank my friends and colleagues at the New York City Department of Health & Mental Hygiene for helping me to discover meaning in my work, encouraging me to go back to school, and allowing me to continue to be involved in the work I care so much about. Lastly, the students at Harvard have enriched my life, and have become some of my closest friends. Words cannot express my gratitude for their support through life’s highs and lows, and for the many successes, failures, and laughs we’ve shared over the past four years.

Finally, I am extremely grateful to my family and friends for giving me love, strength, and confidence, and showing me each day what is important in this life. My grandparents and parents worked tirelessly to bring me into a world rich with opportunity. My grandmother has been a model of confidence and independence, and has taught me how to be comfortable in my own skin. I cherish our relationship. My parents have been my harshest critics and most unwavering champions. They have instilled in me the importance of hard work, perseverance, patience, and compassion. I love them with all of my heart and this dissertation is truly a testament to them. I am tremendously grateful for my relationships with my brother, Jason, Melissa, and my incredible friends, many of whom I’ve known for more than 20 years. And perhaps most deserving of my thanks is Joe, who encouraged me to pursue my dreams and who has stood by my side throughout this journey, despite my flaws and shortcomings. He has shown me unconditional love, patience, and humor when I have needed it most. He is my greatest source of joy and I never could have imagined a better partner in life.

Chapter 1: Trends in Nutrient Content of Children's Menu Items in U.S. Chain Restaurants

Alyssa J. Moran, Jason P. Block, Simo G. Goshev, Sara N. Bleich, Christina A. Roberto

Abstract

Introduction: Restaurant food is widely consumed by children and is associated with poor diet quality. Although many restaurants have made voluntary commitments to improve the nutritional quality of children's menus, it is unclear whether these commitments have led to meaningful changes.

Methods: Nutrients in children's menu items (N=4,016) from 45 chain restaurants were extracted from MenuStat, a database of nutrition information for menu items offered by the nation's largest restaurant chains. Bootstrapped mixed linear models were used to estimate changes in mean calories, saturated fat, and sodium in children's beverages, entrees, side dishes, and desserts between 2012 and 2013, 2014, and 2015. Changes in nutrient content of children's menu items over time were compared among restaurants participating in the Kids LiveWell initiative and restaurants not participating. Types of children's beverages offered each year were also examined. Data were analyzed in 2016.

Results: There was a significant increase in mean beverage calories from 2012-2013 (6 [95% CI=0.8, 10.6]) and from 2012-2014 (11 [3.7, 18.3]), but no change between 2012-2015, and no differences in nutrient content of other items over time. Restaurants participating in Kids LiveWell reduced calories in entrees between 2012-2013 (-24 [-40.4, -7.2]) and between 2012-2014 (-40 [-68.1, -11.4] and increased calories in side dishes between 2012-2015 (49 [4.6, 92.7]) compared to restaurants not participating. Sugar-sweetened beverages consistently constituted 80% of children's beverages, with soda declining and flavored milks increasing between 2012 and 2015.

Conclusions: Results suggest little progress towards improving nutrition in children's menu items. Efforts are needed to engage restaurants in offering healthful children's meals.

Introduction

From 1977 to 2006, energy from restaurant sources increased from 3% to 18% of energy intake among children ages 2-18 years.[1] In 2011-2012, more than one-third of children and adolescents consumed fast-food each day.[2] Among children, greater consumption of restaurant food is associated with higher intake of calories from added sugar and solid fats, as well as poorer diet quality.[3,4] National data indicate that 35% of added sugars and solid fats consumed by children over 2 years of age come from fast-food restaurants. Sugar-sweetened beverages, dairy-based desserts, French fries, and pizza contribute the bulk of these sugars and solid fats.[3] Among children ages 2-11 years, eating at fast-food and full-service restaurants is associated with higher daily energy, saturated fat, sugar, regular soda, and sugar-sweetened beverage intake.[4]

Although there are currently no mandatory nutrition requirements for children's meals in chain restaurants, the restaurant industry has made voluntary commitments to improve the dietary quality of children's menus. In July 2011, the National Restaurant Association launched a voluntary program called Kids LiveWell, which aimed to increase the number of nutritious menu items available to children. By 2015, over 200 restaurant chains with 42,000 locations were participating.[5] Additionally, individual restaurant chains have made voluntary commitments to improving kids' meals outside of the scope of Kids LiveWell. Between 2011-2013, McDonald's replaced French fries and soda in Happy Meals with fruit and low-fat milk.[6] Between 2013-2015, large national chains, including Applebee's, Subway, Chipotle, Arby's, Panera Bread, Wendy's, and Burger King, announced they would remove soda as the default choice on children's menus.[7,8]

Although these voluntary steps to improve children's meals are promising, cross-sectional studies of children's menus in restaurants have found that few options meet guidelines for a healthful diet, such as those put forth by the National School Lunch Program[9] or the Dietary Guidelines for Americans.[10, 11] A recent study of children's entrees and side dishes in 29 chain restaurants found that in 2014, one-third of main dishes at fast-food restaurants and half of main dishes at full-service restaurants exceeded levels of calories, fat, saturated fat, and sodium recommended by the 2010 Dietary Guidelines for Americans.[12] The nutrient content of children's beverages and desserts – two of the four largest contributors to added sugars and solid fats in children's restaurant food – were not assessed. Further, no recent studies have assessed whether changes in nutritional quality of restaurant menu items have occurred since the start of programs like Kids LiveWell and other voluntary restaurant commitments.

To address gaps in the research, this study examined trends in nutrient content of 4,016 beverages, entrees, side dishes, and desserts offered on children's menus in a sample of 45 of the nation's top 100 fast-food, fast-casual, and full-service restaurant chains between 2012 and 2015 to assess whether the nutritional quality of children's restaurant meals has improved during a time when several voluntary restaurant initiatives were implemented. This study also assessed whether the above changes differed between restaurants participating in the National Restaurant Association's Kids LiveWell Initiative and those restaurants not participating.

Methods

Data

Data were obtained from MenuStat (menustat.org) – a census of nutrition data from websites of the nation's largest restaurant chains, identified by U.S. sales.[13] Several published studies have used this database to examine trends in nutritional quality of menu items at restaurants over time.[14-16] A description of Menustat methods is described elsewhere.[17] The sample of restaurant chains used in this study is a balanced panel; all chains offering children's items in each year from 2012-2015 were included (n=45), with children's items designated as any item with "kid," "child," or "children" appearing in the menu item or its description. Characteristics of restaurants were extracted from restaurants' websites.[13] Restaurant chains were "national" if they were located in all U.S. census regions (n=26), otherwise, were "regional" (n=19). Chains were "full-service" if they offered table service (n=16) (e.g., Applebee's), "fast-casual" if they offered at least two of the following: non-disposable utensils, onsite food preparation, no table service, or commitment to higher quality or fresh ingredients or sustainability (n=6) (e.g., Chipotle), and, otherwise, were "fast-food" (n=23) (e.g., Burger King).

Children's menu items from these 45 chains were the sample included in this study. Calories (kcals), sodium (mg), and saturated fat (g), were available for most items from 2012-2015. Some items could not be included because of limited information. Fountain beverages or items listing a range of nutrient data for various combinations (e.g., tacos with a choice of toppings) were added as separate items if descriptions could be matched to nutrient data from Menustat or archived restaurant websites; otherwise, these items were excluded (n=50). After exclusions, 152 (3.7%) items were missing information about calories (n=68), sodium (n=33), and/or saturated fat (n=119). Missing data were imputed based on the following order of preference: (1) obtaining nutrient data directly from restaurants (n=46); (2) searching product or restaurant website archives from the same month and year as Menustat data collection (n=44); (3) calculating nutrient data from an alternate portion size of the same product description (n=3); (4) searching the USDA Standard Reference Database (n=12);[18] or (5) using the last observation carried forward (n=20). Menu items missing data for any nutrient that could not be imputed (n=27) were excluded. Additionally, if an item was the sole item in its menu category within a restaurant (e.g., if a restaurant offered only one dessert), a variance could not be calculated and the item was excluded (n=43).

The final dataset included 4,016 beverages (n=1,886), entrees (n=1,378), side dishes (n=531), and desserts (n=221) (mutually exclusive categories created by MenuStat staff) available in 45 U.S. chain restaurants between 2012-2015 (**Table 1.1**).

Table 1.1 Children's menu item characteristics in 45 U.S. chain restaurants in 2012-2015

	Beverage	Entrée[a]	Side Dish[b]	Dessert
# restaurants offering children's menu items	40	40	33	15
# children's menu items offered				
2012	398	319	112	46
2013	477	316	111	55
2014	470	356	154	60
2015	541	387	154	60
% children's menu items in national restaurants[c]	54.6	54.9	53.5	52.5
% children's menu items by restaurant type				
Full-service restaurants[d]	57.4	31.1	29.8	22.6
Fast-food restaurants[e]	33.4	58.9	59.9	77.4
Fast-casual restaurants[f]	9.2	10.0	10.3	0.0

[a] Includes burgers, entrees, pizza, salads, sandwiches, and soup not categorized as appetizers or side dishes.
[b] Includes appetizers and sides, fried potatoes, and baked goods (i.e., bread, rolls, and biscuits).
[c] Restaurants with locations in all nine U.S. Census Divisions.
[d] Restaurants with table service. Percentage is compared to children's menu items in fast-food or fast-casual restaurants.
[e] Restaurants with no table service and fewer than two of the following criteria: non-disposable utensils, onsite food preparation, no table service, or commitment to higher-quality or fresh ingredients or sustainability.
[f] Restaurants with at least two of four: non-disposable utensils, onsite food preparation, no table service, or commitment to higher-quality or fresh ingredients or sustainability.

Statistical Analyses

Data were analyzed in 2016. A linear model with random intercepts to allow for correlation between items within restaurant chains was used to calculate (1) predicted mean calories in children's beverages and predicted mean calories, saturated fat, and sodium in children's entrees, side dishes, and desserts in 2012; and 2) difference in mean calories in children's beverages and in mean calories, saturated fat, and sodium in children's entrees, side dishes, and desserts between 2012 and 2013, 2014, and 2015. The main independent variable was a year indicator (2012, 2013, 2014, or 2015), and covariates included indicators for whether a restaurant was national, fast-food, fast-casual, or full-service. Even after log transformation, the distribution of beverage calories did not follow a standard normal distribution. Therefore, linear models were cluster bootstrapped with 500 repetitions to compute the standard errors of the regression coefficient estimates from their empirical distributions. The cluster bootstrap provides unbiased estimates of standard errors and does not impose a normal distribution on the data.[19]

In a second set of regressions, an indicator representing participation in Kids LiveWell was added to the previous model with interactions between the participation indicator and year dummies to assess the difference in changes in nutrient content of children's menu items over time among restaurants participating in Kids LiveWell and restaurants not participating. Restaurants joining Kids LiveWell between its launch in July 2011 and January 2015 were identified via the program's website.[5]

Trends in children's beverages were examined in more detail. Beverages were categorized into mutually exclusive groups: sugar-sweetened beverages (>5 calories/item, not described as "100% juice" or white milk), low calorie beverages (≤5 calories/item and not described as "unsweetened"), unsweetened beverages (≤5 calories/item and described as "unsweetened"), 100% juice (described as "100% juice"), and white milk (unflavored). Five was chosen as the threshold for "low calorie" items based on recommendations from the Institute of Medicine Task Force on Nutrition Standards for Foods in Schools, which states that beverages sold in schools, other than 100% juice or milk, should contain less than 5 calories per portion as packaged, meaning less than 5 calories per item.[20, 21] Flavored milks were classified as sugar-sweetened, based on healthy beverage standards that have been previously implemented in large public school districts.[22, 23] Most (87%) beverages in this category contained more than 100 calories per item. Sugar-sweetened beverages were further divided into mutually exclusive categories: soda (carbonated beverages), fruit drinks (excludes "100% juice"), flavored milk, and other sweetened beverages (e.g., sport drinks, smoothies, sweetened teas). Tests for equality of proportions were used to determine whether proportions of beverages within each category differed between 2012 and 2013, 2014, and 2015. All analyses were conducted using Stata Version 13 (College Station, TX).

Results

Table 1.2 shows predicted mean calories, sodium, and saturated fat in children's beverages, entrees, side dishes, and desserts in 2012 and changes between 2012 and 2013, 2014, and 2015. On average, beverages, entrees, side dishes, and desserts contained 139 (SE=5.6), 362 (8.8), 157 (10.4), and 360 (22.0) calories, respectively. Entrees, side dishes, and desserts contained 794 (21.0), 231 (23.5), and 159 (13.1) mg of sodium, and 6.1 (0.3), 1.7 (0.2), and 10.5 (0.9) g of saturated fat, respectively. Between 2012 and 2014, there were small, but significant increases in beverage calories, which increased by 6 (95% CI=0.8, 10.6) calories from 2012 to 2013 and 11 (3.7, 18.3) calories from 2012 to 2014. There was no significant change in beverage calories between 2012 and 2015, and no changes in calories, sodium, or saturated fat in other food categories at any time point between 2012 and 2015.

Table 1.2 Mean per-item nutrients in children's menu items in 2012 and changes from 2012-2015

	Beverage	Entrée[a]	Side Dish[b]	Dessert
Mean (SE), 2012				
Mean (SE) calories (kcals)	139 (5.6)	362 (8.8)	157 (10.4)	360 (22.0)
Mean (SE) sodium (mg)	--	794 (21.0)	231 (23.5)	159 (13.1)
Mean (SE) saturated fat (g)	--	6.1 (0.3)	1.7 (0.2)	10.5 (0.9)
Mean (95% CI) change, 2012-2013				
Calories (kcals)	**6 (0.8, 10.6)***	-8 (-15.4, 0.1)	-5 (-19.6, 10.0)	3 (-15.0, 21.2)
Sodium (mg)	--	-14 (-35.2, 7.0)	-9 (-56.6, 39.2)	10 (-0.7, 20.8)
Saturated fat (g)	--	-0.1 (-0.3, 0.1)	-0.1 (-0.4, 0.2)	0.0 (-0.9, 0.9)
Mean (95% CI) change, 2012-2014				
Calories (kcals)	**11 (3.7, 18.3)****	-2 (-16.3, 11.3)	6 (-13.6, 25.1)	-2 (-24.9, 20.9)
Sodium (mg)	--	5 (-33.4, 42.8)	33 (-20.4, 6.3)	8 (-2.7, 18.9)
Saturated fat (g)	--	0.2 (-0.3, 0.6)	-0.1 (-0.5, 0.3)	-0.2 (-1.2, 0.9)
Mean (95% CI) change, 2012-2015				
Calories (kcals)	6 (-1.4, 14.2)	-1 (-17.0, 14.6)	-6 (-25.7, 13.6)	-10 (-32.5, 13.0)
Sodium (mg)	--	-13 (-54.6, 29.5)	11 (-41.1,63.6)	5 (-7.0, 17.2)
Saturated fat (g)	--	0.2 (-0.3, 0.8)	-0.4 (-0.8, 0.0)	-0.5 (-1.6, 0.5)

Note: Changes in mean per-item calories, sodium, and saturated fat adjusted for whether a restaurant chain is national or not, and restaurant type (fast-food, full-service, fast-casual). Random intercepts for restaurant were included to account for clustering between items within restaurant chains. Coefficients and standard errors are bootstrapped estimates.

Boldface indicates statistical significance (*p<0.05 **p<0.01).

[a] Includes burgers, entrees, pizza, salads, sandwiches, and soups not categorized as appetizers or side dishes.

[b] Includes appetizers and sides, fried potatoes, and baked goods (i.e., bread, rolls, and biscuits).

Table 1.3 shows differences in calories, sodium, and saturated fat in children's menu items in 2012 and changes between 2012 and subsequent years among restaurants participating in Kids LiveWell (n=15) and non-participating restaurants (n=30). Participating restaurants significantly reduced calories between 2012-2013 (-24 [-40.4, -7.2]) and between 2012- 2014 (-40 [-68.1, -11.4]) compared to restaurants not participating, but differences did not persist from 2012-2015. Participating restaurants showed a trend towards increasing calories in children's side dishes across all time periods, although differences between participating and non-participating restaurants were only statistically significant between 2012- 2015 (49 [4.6, 92.7]), and this was largely driven by a reduction in calories among non-participating restaurants. There were no differences between participating and non-participating restaurants with regard to calories in children's beverages or desserts, or with respect to sodium or saturated fat in any menu category.

Table 1.3 Difference in mean per-item nutrients in children's menu items from 2012-2015 among U.S. chain restaurants participating in Kids LiveWell as of January 2015 and non-participating restaurants

Restaurants Participating in Kids LiveWell	Beverage	Entrée[a]	Side Dish[b]	Dessert
Number of restaurants	14	15	14	8
Number of children's menu items	890	639	321	152
<u>Mean (SE), 2012</u>				
Calories (kcals)	143 (10.2)	373 (14.0)	156 (14.9)	350 (21.3)
Sodium (mg)	--	796 (30.9)	252 (34.8)	158 (13.5)
Saturated (g)	--	6.1 (0.4)	1.6 (0.3)	9.3 (0.6)
<u>Mean (95% CI) change, 2012-2013</u>				
Calories (kcals)	3 (-4.0, 10.4)	**-21 (-35.6, -5.9)****	3 (-21.9, 27.2)	-2 (-22.0, 18.5)
Sodium (mg)	--	-30 (-70.0, 9.6)	-7 (-79.1, 65.7)	11 (-1.8, 23.2)
Saturated (g)	--	**-0.4 (-0.7, 0.0)***	0.0 (-0.5, 0.5)	-0.2 (-1.0, 0.5)

(Table 1.3, continued)

Calories (kcals)	13 (-0.1, 25.4)	-24 (-49.2, 1.9)	24 (-7.6, 55.6)	-3 (-31.0, 25.0)
Sodium (mg)	--	-21 (-89.1, 47.3)	53 (-31.4, 136.4)	6 (-2.7, 15.4)
Saturated (g)	--	0.2 (-0.5, 0.8)	0.2 (-0.4, 0.8)	-0.2 (-1.2, 0.9)
Mean (95% CI) change, 2012-2015				
Calories (kcals)	**14 (0.3, 27.1)***	-12 (-39.2, 15.4)	17 (-12.2, 45.5)	-7 (-34.4, 21.5)
Sodium (mg)	--	-24 (-95.1, 46.7)	31 (-48.8, 110.2)	6 (-5.3, 17.1)
Saturated (g)	--	0.5 (-0.2, 1.2)	0.1 (-0.4, 0.6)	-0.4 (-1.3, 0.6)
Restaurants Not Participating in Kids LiveWell	Beverage	Entrée[a]	Side Dish[b]	Dessert
Number of restaurants	26	25	19	7
Number of children's menu items	996	739	210	69
Mean (SE) 2012				
Calories (kcals)	134 (6.1)	349 (9.8)	162 (16.0)	353 (33.1)
Sodium (mg)	--	788 (26.8)	214 (27.6)	151 (21.1)
Saturated (g)	--	6.0 (0.3)	1.8 (0.4)	11.0 (1.7)
Mean (95% CI) change, 2012-2013				
Calories (kcals)	**7 (0.9, 13.7)***	3 (-4.2, 10.3)	-12 (-24.9, 0.2)	12 (-30.2, 54.6)
Sodium (mg)	--	-1 (-24.0, 22.4)	-13 (-50.1, 23.1)	9 (-14.1, 31.4)
Saturated (g)	--	0.1 (-0.1-0.4)	-0.1 (-0.3-0.1)	0.4 (-1.9, 2.7)
Mean (95% CI) change, 2012-2014				
Calories (kcals)	**9 (1.6, 16.3)***	**16 (3.7, 28.5)***	-16 (-39.8, 8.5)	2 (-43.5, 46.7
Sodium (mg)	--	27 (-8.1, 62.3)	3 (-41.1, 47.1)	14 (-17.1, 46.0)
Saturated (g)	--	0.2 (-0.4, 0.7)	-0.4 (-1.0, 0.2)	-0.3 (-2.9, 2.3)
Mean (95% CI) change, 2012-2015				
Calories (kcals)	-1 (-8.7, 7.4)	8 (-9.8, 24.8)	-32 (-64.0, 0.10)	-15 (-58.1, 27.5)
Sodium (mg)	--	-3 (-49.9, 43.1)	-13 (-71.4, 44.9)	6 (-26.7, 38.9)
Saturated (g)	--	0.0 (-0.7, 0.7)	**-0.9 (-1.7, -0.1)***	-0.8 (-3.6, 1.9)
Difference in Difference	Beverage	Entrée[a]	Side Dish[b]	Dessert
Mean (95% CI) change, 2012-2013				
Calories (kcals)	-4 (-13.3, 5.2)	**-24 (-40.4, -7.2)****	15 (-12.7, 42.7)	-14 (-59.7, 31.8)
Sodium (mg)	--	-29 (-76.0, 17.2)	7 (-71.6, 85.1)	2 (-23.5, 27.6)
Saturated (g)	--	**-0.5 (-0.9, -0.1)***	0.1 (-0.4, 0.6)	-0.6 (-3.0, 1.8)
Mean (95% CI) change, 2012-2014				
Calories (kcals)	4 (-10.2, 17.6)	**-40 (-68.1, -11.4)****	40 (-1.3, 80.6)	-5 (-56.8, 47.6)
Sodium (mg)	--	-48 (-126.7, 30.6)	49 (-42.7, 141.7)	-8 (-39.7, 23.5)

(Table 1.3, continued)

Saturated (g)	--	0.0 (-0.9, 0.9)	0.6 (-0.3, 1.4)	0.1 (-2.6, 2.8)
Mean (95% CI) change, 2012-2015				
Calories (kcals)	14 (-1.0, 29.6)	-19 (-50.6, 11.8)	**49 (4.6, 92.7)***	9 (-41.6, 59.2)
Sodium (mg)	--	-21 (-106.2, 64.6)	44 (-57.1, 144.9)	0 (-34.7, 34.2)
Saturated (g)	--	0.4 (-0.5, 1.4)	0.9 (-0.1, 1.9)	0.5 (-2.3, 3.3)

Note: Changes in mean per-item calories, sodium, and saturated fat adjusted for whether a restaurant chain is national or not, and restaurant type (fast food, full service, fast casual). Random intercepts for restaurant were included to account for correlation between items within restaurant chains. Coefficients and standard errors are bootstrapped estimates.

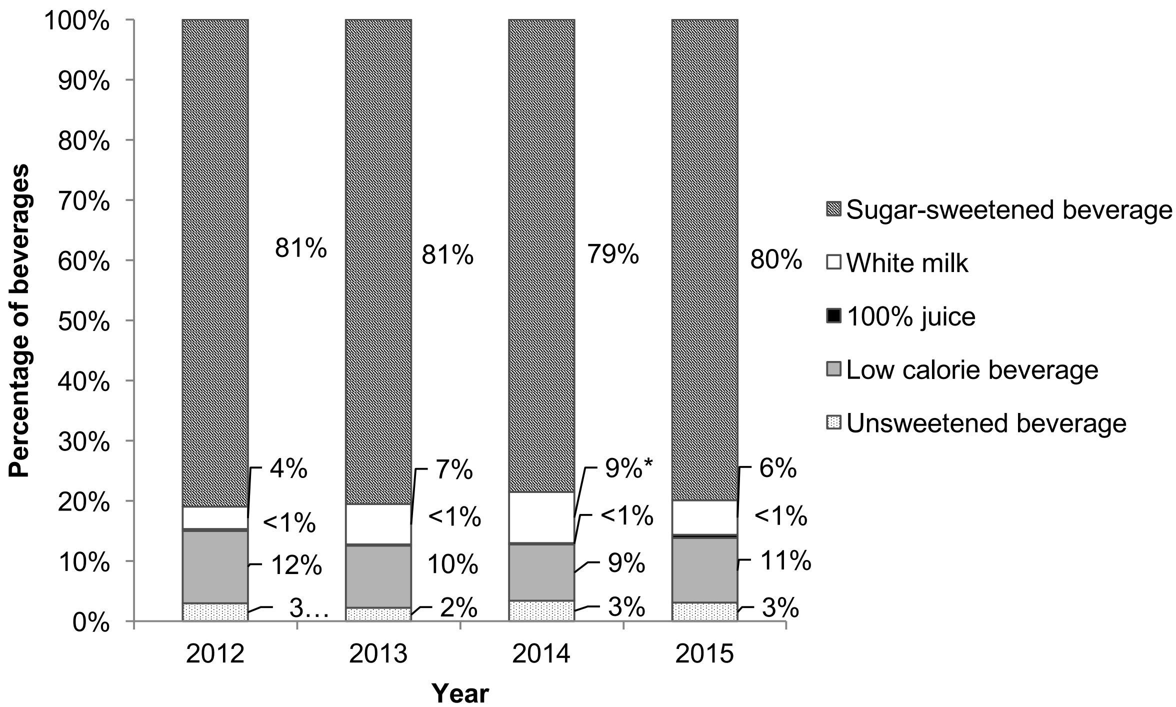
Boldface indicates statistical significance (*P<.05 **P<.01)

a Includes burgers, entrees, pizza, salads, sandwiches, and soups not categorized as appetizers or side dishes.

b Includes appetizers and sides, fried potatoes, and baked goods (i.e., bread, rolls, and biscuits).

Figure 1.1 shows the percentage of children's beverages in each category across time. Sugar-sweetened beverages constituted the largest percentage of beverages in all years, making up 79-81% of beverages.

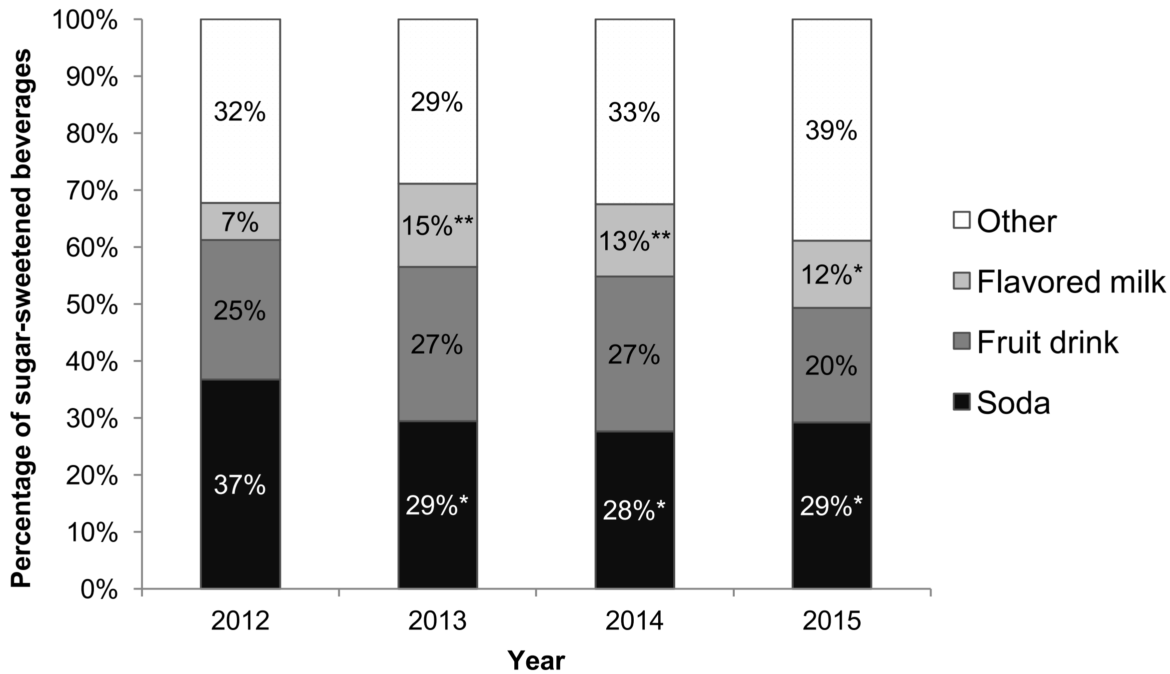
Figure 1.1 Types of children's beverages available in 45 U.S. chain restaurants in 2012-2015



Caption: Figure shows the percentage of beverages (n=1,886) offered on children's menus in 45 U.S. national chain restaurants in 2012-2015 that were sugar-sweetened beverages, white milk, 100% juice, low calorie beverages, or unsweetened beverages. Based on recommendations from the Institute of Medicine Task Force on Nutrition Standards for Foods in Schools, sugar-sweetened beverages were items containing >5 calories/item and not described as "100% juice" or white milk.[18,19] Low calorie beverages were items containing ≤ 5 calories/item and not described as "unsweetened." *Statistically significant change from 2012 (p<0.05).

Within sugar-sweetened beverages, the percentage of options that were regular sodas declined from 2012-2015, dropping from 37% in 2012 to 29% in 2015 (P=0.032) (**Figure 1.2**). The percentage of flavored milks nearly doubled in this time period, rising from 7% of sugar-sweetened beverages in 2012 to 12% in 2015 (P=0.014).

Figure 1.2 Types of children's sugar-sweetened beverages available in 45 U.S. chain restaurants in 2012-2015



Caption: Figure shows the percentage of sugar-sweetened beverages (n=1,507) offered in 45 U.S. national chain restaurants in 2012-2015 that were soda, fruit drinks, flavored milks, or other sugar-sweetened beverages. *Statistically significant change from 2012 (P<0.05) **Statistically significant change from 2012 (P<0.01).

Discussion

There have been no substantial changes in calories, sodium, or saturated fat in children's menu items across multiple years, despite at least 45% of the restaurant sample publically committing to improving kids' meals between 2011 and 2015. There was a significant increase in mean beverage calories between 2012 and 2013 and 2014, but it was very small and there was no difference when comparing 2012 with 2015. Although restaurants participating in Kids LiveWell reduced calories in entrees between 2012 and 2013 and 2014 compared to restaurants not participating, these changes did not persist between 2012 and 2015. Although the availability of soda on menus declined over time, this did not change availability of sugar-sweetened beverages, which consistently constituted nearly 80% of beverages. Flavored milks replaced sodas that were removed from children's menus.

Results from this study are similar to findings from Deierlein and colleagues, who examined nutritional differences in children's entrees and side dishes available for sale in 29 of the top 50 chain restaurants in 2010 and 2014.[12] Consistent with current findings, the authors reported no significant differences in calories, sodium, or saturated fat in children's main dishes or side dishes offered at fast-food restaurants from 2010-2014. The only significant finding was a decrease in calories (-46; $P<.05$) and milligrams of sodium (-128; $P<.05$) among side dishes offered in sit-down restaurants in 2014 compared to 2010. Differences between study findings may have resulted from the difference in restaurants included in the sample (29 of the top 50 vs 45 of the top 100 in this study), or difference in time period assessed (2010 and 2014 vs 2012-2015 in this study).

The findings from this study are in contrast to a 2013 report from Center for Science in the Public Interest, which concluded that restaurants were offering healthier meal combinations.

That study compared all possible combinations of children's meals offered in 34 of the top 50 restaurants in 2008 and 2012 and found that the percentage of meals meeting the Guidelines for Responsible Food Marketing to Children, which apply standards for calories, sodium, and saturated fat from the Dietary Guidelines for Americans[24] and Institute of Medicine Dietary Reference Intakes,[25] increased from 1% in 2008 to 3% in 2012.[26] In addition, the proportion of meals meeting the calorie and sodium standards doubled between 2008 and 2012, increasing from 7% to 14% and 15% to 34%, respectively. The difference in findings might be due to different time periods being analyzed (2008 compared to 2012 versus 2012-2015 for the present study) and/or the way menu items were assessed (all possible combinations versus individual menu items in this study).

If a meal was ordered for a child in 2015 containing an average beverage, entrée, side dish, and dessert, it would contain 1,008 calories, which is nearly twice the USDA's Recommended Dietary Allowance for 4-8 year olds (<533 kcals/meal).[24] An average meal without a beverage would contain 1,189 mg sodium, which is more than 60% of the Institute of Medicine's 1,900 mg daily upper limit for children aged 4-8 years.[25] Meals at the 15 restaurants participating in Kids LiveWell were even higher in calories and sodium than non-participants in 2015, with the average combination containing 1,034 calories and 1,219 mg sodium. Over 200 restaurant chains nationwide are participating in Kids LiveWell, but participants are only required to offer one children's meal and one other item that meet the program's nutrition standards. Strengthening the program's requirements for participation by asking restaurants to adopt the Kids LiveWell standards across a larger proportion of meals, or to adopt specific standards for healthy beverages that are consistent with public health recommendations, may lead to more meaningful improvements in children's menu items.

The trend towards increasing beverage calories despite reductions in soda on children's menus is concerning. Restaurants have received substantial media attention for their efforts to remove soda from children's menus, with at least 15% of restaurants in the study sample announcing voluntary efforts since 2013.[7,8] Though it's possible restaurants will make further changes in future years, as of early 2015, these commitments have not impacted availability of sugar-sweetened beverages on children's menus. When soda was removed from menus, other sweetened beverages replaced them. Restaurants should be encouraged to eliminate all sweetened beverages from children's menus, including flavored milks, fruit drinks, and sport drinks.

Limitations

This study has several limitations. First, only items available on children's menus were assessed, a method that does not account for how items were promoted or which items children are actually purchasing and consuming. Many children, especially adolescents, may be purchasing food from the regular menu. Although availability of unhealthy items on menu boards has been linked to the poor nutritional quality of items purchased, other factors, such as advertisements and combination meals, may impact children's food and beverage choices.[27] A recent study assessing children's menu changes at a regional full-service restaurant found that when fruit and vegetable sides were bundled with children's meals by default, customer orders were more likely to include a healthy side dish.[27] Similarly, McDonald's found that replacing soda with 100% apple juice and low fat milk as the default children's beverage increased juice and milk selections by nine percentage points.[28] By not examining combination meals in this study, improvements to default children's items that could positively impact what children are purchasing and consuming may have been missed.

Additionally, this study's difference-in-difference analysis is subject to limitations. First, results from this analysis were stratified by whether an item was offered in a participating restaurant in each year. Thus, sample sizes for menu categories with fewer total items, particularly desserts, may have been too small to detect significant effects. Second, baseline nutrient data was collected in 2012, but Kids LiveWell was launched at the end of 2011. Although it is unlikely that restaurants would have made significant menu changes in the first few months of the program, any positive changes made between July 2011 and January 2012 would not have been captured in this analysis, thus, biasing results towards the null. Additionally, restaurants in this sample joined Kids LiveWell at different time points between 2011 and 2015, but were labeled as either "participants" or "nonparticipants" across all years. This was done to account for changes participating restaurants may have made in preparation for officially joining the initiative, however, this choice may have diluted the changes made by true program participants in each year, biasing effect estimates towards the null. Third, the difference-in-difference study design assumes parallel trends over time, and this assumption could not be tested because data from an earlier time period were not available. However, all restaurants were within the nation's 100 largest chains, and there are no clear differences between characteristics of participating and non-participating restaurants that would suggest differences with regard to changes in nutrient content of children's menu items over time. Finally, this analysis included only 15 restaurants participating in Kids LiveWell, which is a small subset of the over 200 program participants. Because participating restaurants in this sample are primarily national chain restaurants, results cannot be generalized to smaller regional chains or independent restaurants. Future research is needed to examine the true program effect using a more representative sample of participating restaurants.

Conclusions

Between 2012 and 2015, there was little progress towards improving the healthfulness of children's menu items available in the nation's largest chain restaurants. Broad-reaching efforts to engage restaurants in offering and promoting healthful children's meals, through, for example, public-private partnerships that encourage reformulation or set more rigorous voluntary nutrition standards for kids' meals, are needed to have a bigger impact.

References

1. Poti JM, Popkin BM. Trends in energy intake among US children by eating location and food source, 1977-2006. *J Am Diet Assoc*. 2011 Aug;111(8):1156-64. doi:10.1016/j.jada.2011.05.007.

2. National Center for Health Statistics. Caloric intake from fast-food among children and adolescents in the United States, 2011-2012. http://www.cdc.gov/nchs/data/databriefs/db213.pdf. Published September 2015. Accessed October 21, 2015.

3. Poti JM, Slining MM, Popkin BM. Where are kids getting their empty calories? Stores, schools, and fast-food restaurants each played an important role in empty calorie intake among US children during 2009-2010. *J Acad Nutr Diet.* 2014 Jun;114(6):908-17. doi: 10.1016/j.jand.2013.08.012.

4. Powell LM, Nguyen BT. Fast-food and full-service restaurant consumption among children and adolescents: effect on energy, beverage, and nutrient intake. *JAMA Pediatr*. 2013 Jan;167(1):14-20. doi: 10.1001/jamapediatrics.2013.417.

5. National Restaurant Association. Kids LiveWell website. http://www.restaurant.org/Industry-Impact/Food-Healthy-Living/Kids-LiveWell/About. Accessed October 15, 2015.

6. Nutrition journey 2013 progress report. Boston, MA: McDonald's USA. http://news.mcdonalds.com/getattachment/06344ba3-94c0-4171-90ad-35f304142151. Published September 2013. Accessed October 15, 2015.

7. Center for Science in the Public Interest. Wendy's removes soda from kids' meals. http://cspinet.org/new/201501152.html. Published January 15, 2015. Accessed October 21, 2015.

8. Forbes. Burger King removes soda from kids menus.
http://fortune.com/video/2015/03/10/burger-king-removes-soda-from-kids-menu/. Published March 10, 2015. Accessed October 21, 2015.

9. O'Donnell SI, Hoerr SL, Mendoza JA, Goh ET. Nutrient quality of fast-food kids meals. *Am J Clin Nut*. 2008;88:1388-95.

10. Kirkpatrick SI, Reedy J, Kahle LL, Harris JL, Ohri-Vachaspati P, Krebs-Smith SM. Fast-food menu offerings vary in dietary quality, but are consistently poor. *Public Health Nutr*. 2014 Apr;17(4):924-931. doi: 10.1017/S1368980012005563.

11. Sliwa S, Anzman-Frasca S, Lynskey V, Washburn K, Economos C. Assessing the availability of healthier children's meals at leading quick-service and full-service restaurants. *J Nutr Educ Behav*. 2016 Apri;48(4):242-249.

12. Deierlein AL, Peat K, Claudio L. Comparison of nutrient content of children's menu items at US restaurant chains, 2010-2014. *Nutr J*. 2015;14:80. Doi: 10.1186/s12937-015-0066-4.

13. Nation's Restaurant News. Nation's Restaurant News Top 200. http://nrn.com/nrn-top-200. Published June 26, 2012.

14. Bleich SN, Wolfson JA, Jarlenski MP. Calorie changes in chain restaurant menu items: implications for obesity and evaluations of menu labeling. *Am J Prev Med*. 2015 Jan;48(1):70-5. doi: 10.1016/j.amepre.2014.08.026.

15. Bleich SN, Wolfson JA, Jarlenski MP. Calorie changes in large chain restaurants: declines in new menu items but room for improvement. *Am J Prev Med*. 2016 Jan;50(1):e1-8. doi:10.1016/j.amepre.2015.05.007.

16. Bleich SN, Wolfson JA, Jarlenski MP, Block JP. Restaurants with calories displayed on menus had lower calorie counts compared to restaurants without such labels. *Health Aff (Millwood).* 2015 Nov;34(11):1877-84. doi:10.1377/hlthaff.2015.0512.
17. New York City Department of Health & Mental Hygiene. MenuStat methods. http://menustat.org/methods-for-researchers/. Published January 2016. Accessed February 2016.
18. United States Department of Agriculture, Agriculture Research Service, National Agricultural Library. National nutrient database for standard reference. http://ndb.nal.usda.gov/. Published November 2015. Accessed February 2016.
19. Efron B. Bootstrap methods: another look at the jackknife. *Ann Statist.* 1979;7(1):1-26.
20. IOM (Institute of Medicine). *Nutrition Standards for Foods in Schools: Leading the Way Towards Healthier Youth*. Washington, DC: The National Academies Press. https://www.nationalacademies.org/hmd/~/media/Files/Report%20Files/2007/Nutrition-Standards-for-Foods-in-Schools-Leading-the-Way-toward-Healthier-Youth/factsheet.pdf. Published 2007. Accessed June 29, 2016.
21. Centers for Disease Control and Prevention. *The CDC Guide to Strategies for Reducing the Consumption of Sugar-Sweetened Beverages*. http://www.cdph.ca.gov/SiteCollectionDocuments/StratstoReduce_Sugar_Sweetened_Bevs.pdf. Published March 2010. Accessed June 29, 2016.
22. Gase LN, McCarthy WJ, Robles B, Kuo T. Student receptivity to new school meal offerings: assessing fruit and vegetable waste among middle school students in the Los Angeles Unified School District. *Prev Med*. 2015;67(0 1):S28-S33.

23. Mozaffarian RS, Gortmaker SL, Kenney EL, Carter JE, Howe CW, Reiner JF, et al. Assessment of a districtwide policy on availability of competitive beverages in Boston Public Schools, Massachusetts, 2013. *Prev Chronic Dis.* 2016;13:E32. doi: 10.5888/pcd13.150483.
24. US Department of Agriculture and US Department of Health and Human Services. *Dietary Guidelines for Americans, 2010,* 7th Edition. Washington, DC: US Government Printing Office; December 2010.
25. The National Academies of Sciences, Engineering, Medicine. Institute of Medicine. Dietary reference intakes: water, potassium, sodium, chloride, and sulfate. https://iom.nationalacademies.org/Reports/2004/Dietary-Reference-Intakes-Water-Potassium-Sodium-Chloride-and-Sulfate.aspx. Published Februrary 2004. Accessed April 9, 2016.
26. Center for Science in the Public Interest. Kids' meals: obesity on the menu. https://cspinet.org/new/pdf/cspi-kids-meals-2013.pdf. Published 2013. Accessed October 24, 2015.
27. Anzman-Frasca S, Mueller MP, Sliwa S, Dolan PR, Harelick L, Roberts SB, et al. Changes in children's meal orders following healthy menu modifications at a regional US restaurant chain. *Obesity (Silver Spring).* 2015;23(5):1055-1062. doi: 10.1002/oby.21061.
28. Alliance for a Healthier Generation. McDonald's and Alliance for a Healthier Generation announce progress on commitment to promote balanced food and beverage choices. https://www.healthiergeneration.org/news__events/2015/06/25/1283/mcdonalds_and_alliance_for_a_healthier_generation_announce_progress_on_commitment_to_promote_balanced_food_and_beverage_choices. Published June 25, 2015. Accessed February 12, 2015.

Chapter 2: Consumer underestimation of sodium in fast food restaurant meals: results from a cross-sectional observational study

Alyssa J. Moran, Maricelle Ramirez, Jason P. Block

Abstract

Restaurants are key venues for reducing sodium intake in the U.S., but little is known about consumer perceptions of sodium in restaurant foods. This study quantifies the difference between estimated and actual sodium content of restaurant meals and examines predictors of underestimation in adult and adolescent diners at fast food restaurants. In 2013 and 2014, meal receipts and questionnaires were collected from adults and adolescents dining at six restaurant chains in four New England cities. The sample included 993 adults surveyed during 229 dinnertime visits to 44 restaurants and 794 adolescents surveyed during 298 visits to 49 restaurants after school or at lunchtime. Diners were asked to estimate the amount of sodium (mg) in the meal they had just purchased. Sodium estimates were compared with actual sodium in the meal, calculated by matching all items that the respondent purchased for personal consumption to sodium information on chain restaurant websites. Mean (SD) actual sodium (mg) content of meals was 1,292 (970) for adults and 1,128 (891) for adolescents. One-quarter of diners (176 (23%) adults, 155 (25%) adolescents) were unable or unwilling to provide estimates of the sodium content of their meals. Of those who provided estimates, 90% of adults and 88% of adolescents underestimated sodium in their meals, with adults underestimating sodium by a mean (SD) of 1,013 mg (1,055) and adolescents underestimating by 876 mg (1,021). Respondents underestimated sodium content more for meals with greater sodium content. Education about sodium at point-of-purchase, such as provision of sodium information on restaurant menu boards, may help correct consumer underestimation, particularly for meals of high sodium content.

Introduction

Population-wide sodium reduction is an important strategy for reducing cardiovascular disease and mortality in the U.S., where sodium consumption among children, adolescents, and adults exceeds the Institute of Medicine's upper limit (2,300 mg/day) by nearly 1,000 mg/day.[1-4] In the U.S., adults and adolescents consume nearly 25% of dietary sodium from restaurant sources, and restaurant food contains more sodium per calorie than foods purchased from grocery stores or other food outlets.[2,3] In the National Health and Nutrition Examination Surveys, consumption of restaurant foods is associated with significantly higher average daily sodium intake among adolescents and adults.[5-7] A 2012 study of menu items served by the 400 top-earning restaurants in the U.S. found that the average sodium content of entrees was 1,512 mg, more than half the upper limit recommended for daily consumption.[4,8]

Recognition of the health consequences of high sodium intake and the concentration of such a high proportion of total intake in restaurant food has compelled policymakers to propose measures to highlight items with high sodium levels. The New York City Board of Health recently issued a mandate requiring all restaurants with 15 or more locations to place salt warning labels on items that exceed the recommended daily upper limit of 2,300 mg of sodium.[9] Other municipalities could proceed with similar policies, especially considering prior rapid adoption of calorie labeling after New York City implemented its calorie labeling policy in 2008.[10] Labeling policies intend to correct a perceived consumer knowledge deficit and have successfully increased consumer knowledge and awareness of health risks in other settings. For example, there is evidence that placing prominent text warning labels on cigarette packages increased consumer risk perceptions and decreased intent to purchase cigarettes.[11] In experimental settings, similar effects have been found when health warning labels are displayed prominently on sugary drinks.[12,13] Although research on how calorie labels in restaurants influence consumer food choices has been mixed, several studies have found that the labels increase consumer awareness of calories, and may influence purchase intentions, particularly when the information displayed defies consumer expectations.[10,14-18]

Sodium warning labels may have a similar effect on consumer awareness of sodium in restaurant food; however, little research has documented this. Experimental studies have found that consumers likely significantly underestimate sodium in restaurant foods. In a 2006 study, 193 adults received a mail survey and were asked to estimate the sodium content of several selected restaurant items. Participants underestimated sodium content in entrees by 115-811%, with less accuracy for the highest sodium items.[19]

The aim of this study was to fill a gap in our understanding of consumer knowledge of sodium in restaurant foods by examining the accuracy of consumer estimates of sodium in restaurant meals. To our knowledge, this is the first study to assess consumer estimates of sodium in a real-world setting and the first study of any kind to examine sodium estimates among adolescents. Using a sample of adolescents and adults dining at six fast food restaurant chains in four New England cities, this study quantified the difference between estimated and actual sodium content of restaurant meals and examined predictors of underestimation. Consistent with prior studies of nutrition knowledge and label reading, we hypothesized that age, gender, race, body mass index, restaurant chain, importance of nutrition information in making food choices, and ability to accurately estimate recommendations for daily sodium intake would be associated with accuracy of sodium estimation.[10,20,21] This research provides evidence quantifying consumer misperceptions about sodium in restaurant food and potential demographic disparities, which will inform ongoing policy debates around the need for sodium warning labels, or other methods for conveying sodium information, in restaurant settings.

Methods

Study Design

Data for this study were collected in the context of a separate study evaluating the effects of calorie labels on adult, adolescent, and child fast-food meal purchases. Data for the calorie labeling study were collected from 2010-2014, but questions about sodium were not added to adult and adolescent questionnaires until June 2013. This analysis is based on the subsample of adults and adolescents who were asked questions about sodium in 2013 and 2014. Data were collected from June-September in 2013 and May-September in 2014.

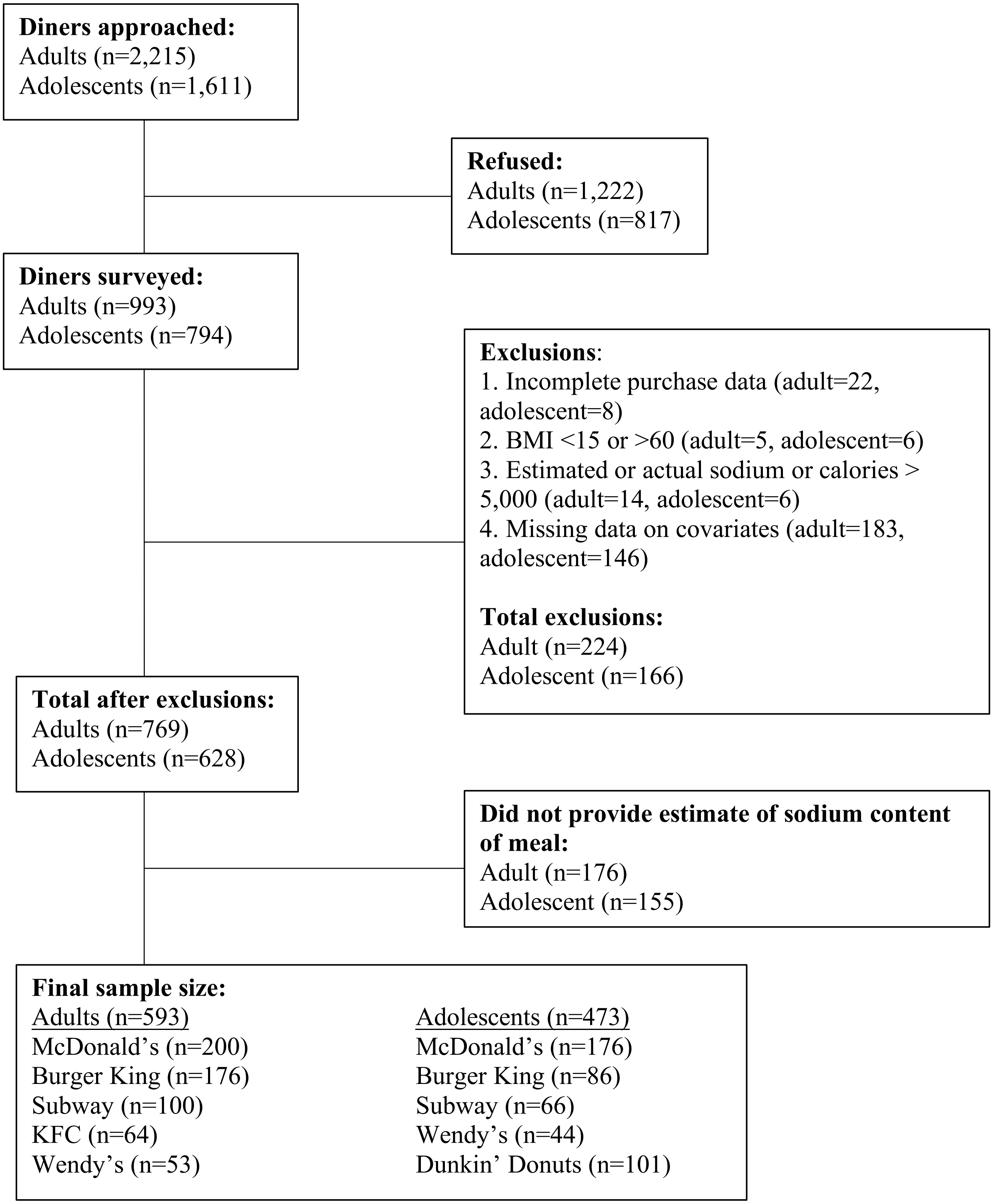
Restaurants selected for the study were located in four New England cities: Boston, MA; Springfield, MA; Providence, RI; and Hartford, CT. These cities range in size from 179,000-650,000 people and are demographically diverse, with populations ranging from 16-38% black, 18-44% Hispanic, and 22-33% of individuals in poverty.[22] Restaurant chains with the highest U.S. sales and at least two locations in each city were selected for the adult sample, and restaurant chains with at least two locations within one mile of a high school were selected for the adolescent sample. The restaurant chains for the adult sample were McDonald's, Burger King, Wendy's, Kentucky Fried Chicken (KFC) and Subway. The same restaurant chains were used for the adolescent sample except Dunkin' Donuts was substituted for KFC. A detailed description of restaurant chain sampling has been described elsewhere.[23] No restaurant chains in the adult or adolescent sample printed sodium information on menus. In some stores, sodium information was available on wall posters, food containers/wrappers, napkins, or cups. All chains listed nutrition information, including sodium content, on their websites.

Street intercept survey methodology was used to collect data from participants outside restaurant entrances or, if research assistants were not permitted to work on the restaurant's property, on a public sidewalk adjacent to the restaurant. Every effort was made to visit the same restaurants in 2013 and 2014; however, this was not always possible due to management refusals. In the adolescent sample, four of 36 restaurants visited in 2013 were replaced with two new restaurants in 2014 and in the adult sample four of 43 restaurants visited in 2013 were replaced with three new restaurants in 2014. Research assistants approached diners who appeared eligible based on age for each of the samples and asked them to save their receipts if interested in participating in a study about "choices in fast food restaurants." Age eligibility for the different samples was 18+ years of age for adults and 11 to 20 years of age for adolescents. The adolescent group included a relatively wide range of ages, from adolescent to young adult, but we refer to this group as "adolescents" for the ease of presentation. We included this wide range of age for the adolescent category to recruit as many young people as possible. While there was age overlap between the two samples, it was highly unlikely that individuals would cross over both samples as we collected data at lunchtime for adolescents and in the evening for adults. When customers exited the restaurant, research assistants collected receipts, asked participants to identify items (or portions of items, if items were intended for sharing) purchased for individual consumption, and completed an item questionnaire. The item questionnaire clarified details about the order, such as whether the meal was shared, fountain beverage choices, and meal customization (e.g., addition of condiments or dipping sauces). A respondent's meal was defined as all purchased items intended for individual consumption. To calculate actual calorie and sodium content of meals, information for each item on receipts was linked to nutrition information from restaurant websites, collected in July of each year of data collection. Research comparing nutrition information on restaurant menus to measurements taken in a lab shows that the stated energy content of restaurant foods is generally accurate.[24] While no studies have validated the accuracy of sodium information stated on restaurant websites, a study of Canadian food labels found that laboratory values for sodium were within 20% of stated values for most items.[25] A brief questionnaire was administered to capture the participant's estimation of the meal's calorie and sodium content, importance of calories, convenience, price, and taste in food choices ("a lot," "a little," or "not at all"), awareness of calorie information in the restaurant ("yes," "no," "unsure"), BMI (calculated from self-reported height and weight), and basic demographic information (age, gender, race/ethnicity). Participants were also asked to estimate the average daily calorie (kcal) and sodium (mg) recommendations ("Less than 1,000," "At least 1,000 but no more than 2,000," "At least 2,000 but no more than 3,000," "At least 3,000 but no more than 4,000," "At least 4,000 but no more than 5,000," "Greater than 5,000"). For both calories and sodium, a wide range of estimates (1,000-3,000) was considered accurate to allow for variation within individuals included in this study. Estimates of less than 1,000 were considered underestimates, and estimates greater than 3,000 were considered overestimates. Questionnaires were administered in English, but were available in Spanish to guide participants who were Spanish-speaking and had limited English proficiency. Each participant received a $2 gift card for enrolling in the study.

Statistical Analysis

For this study, 993 adults were surveyed during 229 visits to 44 restaurants, and 794 adolescents were surveyed during 298 visits to 49 restaurants (**Figure 2.1**). Of the participants surveyed, 22 (2%) adult and 8 (1%) adolescent surveys were excluded due to incomplete information on foods purchased. Nineteen (2%) adults and 12 (2%) adolescents were excluded due to outlier values for estimated or actual sodium or calories (>5,000 kcals and >5,000 mg, respectively) or outlier values for BMI (<15 or >58 kg/m^2). For consistency across statistical models, participants missing data on covariates were also excluded (183 (18%) adults, 146 (19%) adolescents). After exclusions, the sample included 769 adults and 628 adolescents. Of these, 176 (23%) adults and 155 (25%) adolescents did not provide an estimate of the sodium in their meals and thus were not eligible for inclusion in the final analysis. The final sample for analyzing estimation of sodium content included 593 adults and 473 adolescents.

Figure 2.1 Flow diagram of sampling selection and total number of adults and adolescents included in the analysis



Characteristics of respondents who did versus did not provide estimates of meal sodium content were compared using Student's t-tests for age, BMI, and mean of meal sodium content and Chi-squared tests were used to compare year of data collection, sex, race/ethnicity, importance of taste, calories, price, and convenience in food choices, whether or not the participant noticed calorie information in the restaurant, and estimates of the daily sodium recommendation.

Among those respondents who provided sodium estimates, multivariable linear models were used to identify predictors of underestimation of sodium content. The model outcome was the difference between estimated and actual sodium content; independent variables included restaurant chain and multiple other predictors determined *a priori* as possible determinants of estimated sodium content, including underestimation of calorie content (as a proxy for nutrition knowledge), age, BMI, year of data collection, gender, race/ethnicity, whether participants noticed calorie information in the restaurant, importance of calories, taste, price, and convenience in food choices, and accuracy of estimates of the daily sodium recommendation. Actual sodium content was mean-centered; intercepts from each model represent the degree of underestimation for meals of mean actual sodium content. Positive parameter estimates indicate better estimation of sodium content per unit increase for linear predictors or compared with a reference group for categorical predictors. Data were analyzed in 2015 using SAS Version 9.4 (Cary, NC).

Results

Most diners were of non-white race/ethnicity (377 (64%) adults, 377 (80%) adolescents), and just over 50% of respondents in both samples were male (**Table 2.1**). Taste was the most important driver of food choices, with over three quarters of participants reporting taste mattered "a lot" (481 (81%) adults, 356 (75%) adolescents). Most participants underestimated the daily sodium recommendation (486 (82%) adults, 314 (66%) adolescents).

Several differences were evident when comparing characteristics of participants who provided sodium estimates and those who did not (sodium "non-responders"). In the adult sample, non-responders were slightly older (mean [SD] age=36.8 [14.8] for responders vs 39.7 [15.6] for non-responders) and were more likely to be of white race (n [%] white=216 [36] vs 85 [48]). Fewer non-responders reported taste mattered "a lot" when making food choices (481 [81] vs 124 [70]) and, surprisingly, non-responders were more likely to accurately estimate the daily sodium recommendation (98 [17] vs 55 [31]). Among adolescents, there were more non-responders in 2014 (274 [58] vs 110 [71]), and non-responders were less likely to report price mattered "a lot" for food choices (140 [30] vs 25 [16].

Table 2.1 Characteristics of adults and adolescents purchasing meals from fast food restaurant chains in four cities in New England, US, 2013 and 2014, and responses to questionnaire items.

	Adults			Adolescents		
	Provided estimate of sodium content of meal (n=593)	**Did not provide estimate of sodium content of meal (n=176)**	**P-value**	**Estimated sodium content of meal (n=473)**	**Could not provide estimate of sodium content of meal (n=155)**	**P-value**
Mean (SD) **sodium purchased** (mg)	1292 (970)	1280 (818)	0.87	1128 (891)	1091 (823)	0.65
Mean (SD) **age** (years)	36.8 (14.2)	39.7 (15.6)	**0.02**	16.2 (2.7)	16.6 (2.8)	0.10
Mean (SD) **BMI**	28.3 (5.9)	28.1 (6.3)	0.80	23.9 (4.8)	24.6 (5.7)	0.16
Year			0.85			**<0.01**
2014	271 (46)	79 (45)		274 (58)	110 (71)	
2013	322 (54)	97 (55)		199 (42)	45 (29)	
Gender			0.83			0.82
Male	328 (55)	99 (56)		249 (53)	80 (52)	
Female	265 (45)	77 (44)		226 (47)	75 (48)	
Race			**<0.001**			0.90
White	216 (36)	85 (48)		96 (20)	30 (19)	
Black	201 (34)	39 (22)		182 (38)	55 (35)	
Hispanic	112 (19)	34 (19)		116 (24)	42 (27)	
Asian	28 (5)	0 (0)		24 (5)	7 (5)	
Other race	36 (6)	18 (10)		57 (12)	21 (14)	
Taste important in food choice:			**0.01**			0.06
A Lot	481 (81)	124 (70)		356 (75)	112 (72)	
A Little	86 (15)	41 (23)		84 (18)	38 (25)	
Not at All	26 (4)	11 (6)		33 (7)	5 (3)	
Calories important in food choice:			0.73			0.06
A Lot	173 (29)	46 (26)		103 (22)	21 (14)	
A Little	136 (23)	43 (24)		131 (28)	42 (27)	
Not at All	284 (48)	87 (49)		239 (51)	92 (59)	
Price important in food choice:			0.19			**<.01**
A Lot	265 (45)	70 (40)		140 (30)	25 (16)	
A Little	177 (30)	49 (28)		163 (34)	72 (46)	

(Table 2.1, continued)

Not at All	151 (25)	57 (32)		170 (36)	58 (37)	
Quick to eat important in food choice:			0.16			0.16
A Lot	301 (51)	80 (45)		154 (33)	38 (25)	
A Little	161 (27)	45 (26)		154 (33)	59 (38)	
Not at All	131 (22)	51 (29)		165 (35)	58 (37)	
Noticed calorie information in restaurant:			0.15			0.47
Yes	189 (32)	61 (35)		119 (25)	41 (26)	
No	371 (63)	99 (56)		294 (62)	89 (57)	
Unsure	33 (6)	16 (9)		60 (13)	25 (16)	
Estimate of daily sodium recommendation:			**<0.001**			0.07
Accurate (1000-3000 mg/day)	98 (17)	55 (31)		137 (29)	59 (38)	
Underestimated (<1000 mg/day)	486 (82)	118 (67)		314 (66)	92 (59)	
Overestimated (>3000 mg/day)	9 (2)	3 (2)		22 (5)	4 (3)	

Figures are numbers (percentage of participants) unless stated otherwise. P-values are for Student's t-tests (continuous variables) or Chi-square tests (categorical variables) for differences between participants who provided and could not provide an estimate of the amount of sodium in his/her meal. Boldface indicates statistical significance (p<0.05).

For those participants providing sodium estimates, mean (SD) actual sodium (mg) content of meals was 1,292 (970) for adults and 1,128 (891) for adolescents (**Table 2.2**). More than 10% of participants purchased meals containing more than 2,300 mg of sodium (76 (13%) adult meals, 52 (11%) adolescent meals). More than 85% of participants underestimated sodium in their meals (534 (90%) adults, 415 (88%) adolescents), and more than 60% underestimated by more than 500 mg (389 (66%) adults, 297 (63%) adolescents).

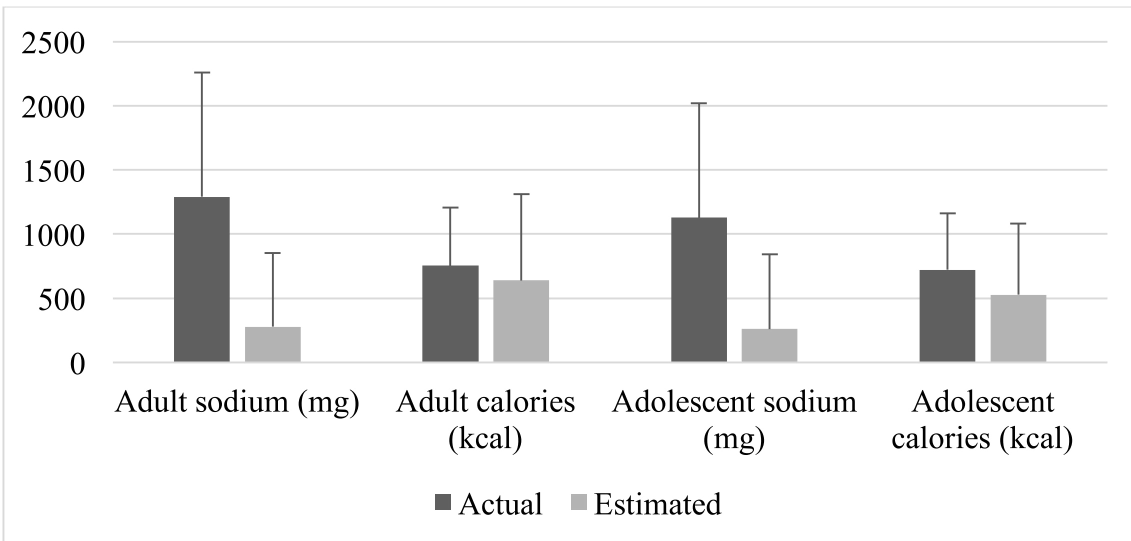
Table 2.2 Characteristics of meals* purchased at fast food restaurant chains in four cities in New England in 2013 and 2014 by adults and adolescents included in study of consumers' estimates of sodium content of meals.

	Adults (n=593)	Adolescents (n=473)
Sodium content of meals:		
Mean (SD; range) actual content in mg	1292 (970; 0, 4970)	1128 (891; 0, 4435)
Median (IQR) actual content in mg	1220 (550, 1800)	990 (340, 1725)
Mean (SD; range) estimated content in mg	279 (572; 0, 5000)	261(582; 0, 5000)
Median (IQR) estimated content in mg	50 (12, 300)	50 (15, 250)
Difference between estimated and actual sodium content:		
Mean in mg (SD, range)	-1013 (1055; -4880, 3400)	-876 (1021; -3835, 4200)
Median in mg (IQR)	-940 (-1580, -190)	-805; -1480, -144)
Calorie content of meals:		
Mean (SD; range) actual content	754 (451; 0, 2540)	723 (438;0, 2320)
Median (IQR) actual content	680 (390, 1070)	660 (360, 1030)
Mean (SD; range) estimated content	639 (674; 0, 5000)	527 (554; 0, 5000)
Median (IQR) estimated content	500 (250, 800)	400 (200, 700)
Difference between estimated and actual calorie content:		
Mean (SD; range)	-114 (707; -2460, 4680)	-196 (583; -1750, 4060)
Median (IQR)	-140 (-460, 60)	-190 (-500, 0)
Mean (SD) difference between estimated and actual sodium content by restaurant:		
McDonald's	-720 (827)	-611 (942)
Burger King	-1009 (1099)	-1367 (973)
Subway	-1413 (1079)	-1389 (1330)
KFC	-1499 (1206)	--
Wendy's	-789 (1011)	-1257 (841)
Dunkin' Donuts	--	-373 (529)

*Meals defined as all purchased items intended for individual consumption. Figures are numbers (percentage) unless stated otherwise.

The mean difference between estimated and actual sodium (the underestimate) was -1,013 mg (1,055) for adults and -876 mg (1,021) for adolescents (**Figure 2.2**). Mean underestimation of sodium varied by restaurant, and was greatest at KFC (-1,499 [1,206]) in the adult sample and at Subway (-1,389 [1,330]) in the adolescent sample.

Figure 2.2 Mean (SE) difference between actual and estimated calories (kcals) and sodium (mg) in meals purchased by a sample of adults and adolescent dining at fast-food restaurants



In the multivariable linear models, there was a linear association between actual sodium content and underestimation of sodium in both the adult and adolescent samples (**Table 2.3**). Intercepts represent mean sodium underestimation (mg) for meals of average sodium content, which was -1,243 (95% CI=-1,595, -890) for adults and -600 (-1,079, -121) for adolescents. In both samples, underestimation increased as mean sodium content of the meal increased (b=-0.88 [95% CI= -0.94, -0.83] for adults; -0.95 [-1.02, -0.88] for adolescents). Based on these parameter estimates, for every 1 mg increase in sodium content of the meal, underestimation increased by 0.88 mg for adults and by 0.95 mg for adolescents. Accuracy of calorie estimates was associated with accuracy in sodium estimates for adults only. For every 1 kcal improvement in estimates of calorie content, estimation of sodium content improved by 0.15 mg.

In the adult sample, women (135.62 [42.08, 229.17]) and participants who identified as Asian (239.42 [18.35, 460.49]) underestimated sodium less than men and participants who identified as white, respectively. Participants who did not notice calories posted in the restaurant underestimated sodium more than people who noticed calories (-122.03 [-225.71, -18.36]). Compared to participants who accurately estimated the daily sodium recommendation, those who underestimated the recommendation also underestimated meal sodium content more (-156.34 [-282.91, -29.76]). Similarly, adolescent diners who overestimated the daily sodium recommendation were better at estimating the sodium content of their meals (328.23 [69.81, 586.64]) compared to those who provided an accurate estimate of the daily recommendation. While there were no significant differences between adolescents who did and did not notice calories posted in restaurants, those reporting calories were important in food choices provided more accurate estimates of sodium in their meals compared to diners who reported calories were “not at all” important (168.26 [32.93, 303.58]).

In the adult sample, there was little difference in estimation by restaurant chain, however, adolescent diners at Burger King (-195.33 [-352.41, -38.24]) and Dunkin’ Donuts (-222.52 [-371.53, -73.51]) provided worse estimates of the sodium in their meals, compared to diners at McDonald’s. There were no differences in sodium estimation by year of data collection or BMI in either sample.

Table 2.3 Predictors of sodium estimation among adults and adolescents purchasing meals at fast food restaurant chains in four cities in New England, US, 2013 and 2014

	Adults (n=593) b (95% CI)	P-Value	Adolescents (n=473) b (95% CI)	P-Value
Intercept	-1243 (-1595, -890)	**<0.001**	-600 (-1079, -121)	**0.01**
Actual sodium content	-0.88 (-0.94, -0.83)	**<0.001**	-0.95 (-1.02, -0.88)	**<0.001**
Difference between actual and estimated calories	0.15 (0.08, 0.22)	**<0.001**	0.06 (-0.31, 0.16)	0.19
Age (per year)	2.01 (-1.38, 5.40)	0.24	6.95 (-14.79-28.70)	0.53
BMI (per 5 points)	20.24 (-19.63, 60.12)	0.32	-32.37 (-90.69, 25.96)	0.28
Year				
2014	0.0 (ref)		0.0 (ref)	--
2013	58.92 (-34.46, 154.30)	0.23	86.08 (-25.81, 197.98)	0.13
Gender				
Male	0.0 (ref)		0.0 (ref)	--
Female	135.62 (42.08, 229.17)	**<0.01**	-88.08 (-193.39, 17.24)	0.10
Race/ethnicity				
White	0.0 (ref)		0.0 (ref)	--
Black	-20.71 (-131.97, 90.55)	0.71	126.66 (-21.13, 274.46)	0.09
Hispanic	10.76 (-121.36, 142.88)	0.88	21.01 (-140.65, 182.67)	0.80
Asian	239.42 (18.35, 460.49)	**0.03**	-68.17 (-329.79, 193.44)	0.93
Other race	31.23 (-169.69, 232.16)	0.76	151.64 (-39.02, 342.30)	0.12
Restaurant chain				
McDonald's	0.0 (ref)		0.0 (ref)	--
Burger King	93.49 (-24.38, 211.36)	0.12	-195.33 (-352.41, -38.24)	**0.01**
Wendy's	149.65 (-22.56, 321.86)	0.09	-166.48 (-360.0, 27.03)	0.09
KFC	106.59 (-68.68, 281.86)	0.23	--	--
Subway	29.80 (-114.14, 173.75)	0.68	-96.55 (-267.77, 74.67)	0.27
Dunkin' Donuts	--	--	-222.52 (-371.53, -73.51)	**<0.01**
Type 3 F-test for chain difference		0.62		**<0.01**
Noticed posted calories in restaurant				
Yes	0.0 (ref)		0.0 (ref)	--
No	-122.03 (-225.71, -18.36)	0.02	-37.04 (-164.63, 90.56)	0.57
Unsure	-162.33 (-378.98, 54.31)	0.14	-41.50 (-230.52, 147.50)	0.67
Importance of calories in food choice				
Not at all	0.0 (ref)		0.0 (ref)	
A little	4.44 (-112.99, 121.87)	0.94	55.85 (-72.93, 184.62)	0.39

(Table 2.3, continued)

A lot	11.39 (-100.11, 122.89)	0.84	168.26 (32.93, 303.58)	**0.01**
Personal estimate of daily sodium requirement				
Accurate (1000-3000mg/day)	0.0 (ref)		0.0 (ref)	--
Underestimated (<1000mg/day)	-156.34 (-282.91, -29.76)	**0.02**	-90.82 (-207.14, 25.50)	0.13
Overestimated (>3000mg/day)	113.70 (-272.35, 499.75)	0.56	328.23 (69.81, 586.64)	**0.01**

Discussion

In this study of diners at fast food restaurants in four New England cities, nearly one-quarter of adults and adolescents did not provide estimates of the sodium content of their meals. The majority of those who provided a response substantially underestimated the amount of sodium in the meal they purchased. Average sodium content of meals – 1,128 mg for adolescents and 1,292 mg for adults – was approximately half the daily limit recommended by the *2015-2020 Dietary Guidelines for Americans*.[26] On average, consumers underestimated sodium in their meals by 50-100%, and the degree of underestimation increased as sodium in meals increased. This study is the first to quantify underestimation of sodium content in real-world settings, among diners at restaurants.

These results are consistent with studies of sodium estimation in other types of settings. In a mail survey of 193 adults asked to estimate nutrient content of nine restaurant entrees, over 90% of participants underestimated sodium, and underestimation increased from 254% for the lowest sodium items (mean actual sodium=1,180 mg, mean estimated sodium=333 mg) to 811% for the highest sodium items (mean actual=4,890 mg, mean estimated=537 mg).[19] In an experimental study of 3,080 adults randomized to receive different labeling on restaurant menus, 18% of participants who were randomized to menu labels with sodium information were "shocked" by the amount of sodium in their meals.[27] Taken together, these findings suggest meaningful misperceptions about sodium in restaurant foods, which is of particular concern given that 53% of U.S. adults, and up to 83% of adults who have received advice from a medical professional, report actively trying to reduce dietary sodium.[28]

This study found significant differences in sodium estimation by chain. Compared to McDonald's, adolescents had worse estimates of sodium at Dunkin' Donuts – findings that are likely related to consumer perceptions of the types of foods served at these restaurants. Core menu items at McDonald's are mainly savory (e.g., hamburgers, French fries), while Dunkin' Donuts sells primarily sweet foods (e.g., donut, pastries, muffins), which may be perceived as being lower in sodium. In a 2011 industry survey, 55% of consumers identified salty snacks, like chips and crackers, as having high amounts of sodium per serving, and 54% identified meats as high sodium. By contrast, only 3% identified baked goods, like cakes and muffins, as being high in sodium.[29] Although a Dunkin' Donuts muffin contains more than 20% of the recommended daily sodium limit,[30] consumers may underestimate sodium because the food does not taste salty. Further investigation is needed to determine whether this phenomenon is consistent across similar restaurants.

This study found significant differences in sodium estimation by race and gender in the adult sample. Better estimation by women is consistent with prior studies of calorie menu labeling, which have found that women are more likely than men to report calorie information as helpful in guiding choices[31] and more likely to use calorie information when dining at fast-food restaurants.[14] Better estimation by Asian adults might result from high sodium content of traditional Asian diets; this high sodium content could plausibly lead to greater awareness of salt in this population.[32]

Awareness and use of calorie information appeared to have a modest association with sodium estimation in both samples. Among adults, better calorie estimation and noticing calories posted in the restaurant were associated with more accurate sodium estimates. In the adolescent sample, identifying calorie content of meals as an important factor when choosing restaurant items was associated with more accurate sodium estimates. These findings could be due to better overall nutrition knowledge among diners who can more accurately estimate calories, or the association could simply arise because of correlations between sodium and calorie content of meals (i.e., if higher calorie meals tend to also be higher in sodium, calorie labels are also conveying some information about sodium). If the latter is true, increasing the salience and use of calorie information may improve awareness of sodium for some items. Future studies are needed to assess how provision of calorie and sodium information, separately or in combination, influence consumer awareness of sodium, and, ultimately, sodium content of meals purchased.

Limitations

There are several limitations to this study that should be considered when interpreting results. During the study, diners who would likely qualify for inclusion based on age, but who chose not to participate, were tracked. Of those approached, 45% of adults and 49% of adolescents agreed to enroll in the study; this was not surprising considering the fast-paced environment in which data were collected. Nonresponse could bias effect estimates in either direction depending on characteristics of non-participants. If more educated diners were not motivated to participate in the study, due to the small monetary incentive, and those diners would have provided more accurate estimates of sodium, parameter estimates could have been biased away from the null. By contrast, diners with no interest in nutritional information might have been unmotivated to participate and less likely to correctly estimate sodium content, thereby biasing results toward the null. Due to the street intercept methodology, extensive questions about participant demographics and socioeconomic status could not be asked, and data on factors that may influence nutrition knowledge, such as income or education, were not collected.

Additionally, actual food consumption could not be measured so this study relied on receipts and diner reports of foods purchased.

Conclusion

In this study of diners at six fast food restaurant chains in four New England cities, adults and adolescents substantially underestimated sodium, with underestimation greatest in the highest sodium meals. Adolescents at Dunkin' Donuts underestimated sodium more than diners at other chains. Policies mandating provision of sodium information on menu boards, such as New York City's Sodium Warning Label Resolution, may help correct consumer underestimation, particularly for meals of high sodium content.

References

1. Consensus Statement on Sodium. New York, NY: New York City Department of Health & Mental Hygiene and American Heart Association. http://www.nyc.gov/html/doh/html/pr2014/pr017-14.shtml. Published June 24, 2014. Accessed January 11, 2016.
2. Cogswell ME, Yuan K, Gunn JP, Gillespie C, Sliwa S, Galuska DA, et al. Vital signs: sodium intake among U.S. school-aged children – 2009-2010. *MMWR Morb Mortal Wkly Rep*. 2014 Sep 12;63(36):789-97.
3. Centers for Disease Control and Prevention (CDC). Vital signs: food categories contributing the most to sodium consumption – United States, 2007-2008. *MMWR Morb Mortal Wkly Rep*. 2012 Feb 10;61(5):92-8.
4. National Academies of Sciences, Engineering, Medicine. Institute of Medicine (2004). *Dietary reference intakes: water, potassium, sodium, chloride, and sulfate*. Retrieved from https://iom.nationalacademies.org/Reports/2004/Dietary-Reference-Intakes-Water-Potassium-Sodium-Chloride-and-Sulfate.aspx
5. An R. Fast-food and full-service restaurant consumption and daily energy and nutrient intakes in US adults. *Eur J Clin Nutr*. 2016 Jan;70(1):97-103. doi: 10.1038/ejcn.2015.104.
6. Nguyen BT, Powell LM. The impact of restaurant consumption among US adults: effects on energy and nutrient intakes. *Public Health Nutr*. 2014 Nov;17(11):2445-52. doi: 10.1017/S1368980014001153.

7. Powell LM, Nguyen BT. Fast-food and full-service restaurant consumption among children and adolescents: effect on energy, beverage, and nutrient intake. *JAMA Pediatr*. 2013 Jan;167(1):14-20. doi: 10.1001/jamapediatrics.2013.417.
8. Wu H, Sturm R. What's on the menu? A review of the energy and nutritional content of US chain restaurant menus. *Public Health Nutr.* 2013 Jan;16(1):87-96. doi: 10.1017/S136898001200122X.
9. New York City, NY, New York City Health Code, §81.49 (2015).
10. Long MW, Tobias DK, Cradock AL, Batchelder H, Gortmaker SL. Systematic review and meta-analysis of the impact of restaurant menu calorie labeling. *Am J Public Health*. 2015;105(5):e11-24.
11. Hammond D. Health warning messages on tobacco products: a review. *Tob Control*. 2011 Sep;20(5):327-37.
12. Roberto CA, Wong D, Musicus A, Hammond D. The influence of sugar-sweetened beverage health warning labels on parents' choices. *Pediatrics*. 2016;137(2):e20153185.
13. VanEpps EM, Roberto CA. The influence of sugar-sweetened beverage warnings: a randomized trial of adolescents' choices and beliefs. *Am J Prev Med*. 2016;51(5):664-672.
14. Chen R, Smyser M, Chan N, Ta M, Saelens BE, Krieger J. Changes in awareness and use of calorie information after mandatory menu labeling in restaurants in King County, Washington. *Am J Public Health*. 2015 Mar;105(3):546-53. doi: 10.2105/AJPH.2014.302262.

15. Dumanovsky T, Huang CY, Bassett MT, Silver LD. Consumer awareness of fast-food calorie information in New York City after implementation of a menu labeling regulation. *Am J Public Health.* 2010;100(12):2520-5.

16. Krieger J, Chan CL, Saelens BE, Ta ML, Solet D, Fleming DW. Menu labeling regulations and calories purchased at chain restaurants. *Am J Prev Med*. 2013;44(6):595-604.

17. Burton S, Howlett E, Tangari AH. Food for thought: how will the nutrition labeling of quick service restaurant menu items influence consumers' product evaluations, purchase intentions, and choices? *Journal of Retailing*. 2009;85(3):258-273.

18. Reale S, Flint SW. Menu labeling and food choice in obese adults: a feasibility study. *BMC Obesity*. 2016;3(17).

19. Burton S, Creyer EH, Kees J, Huggins K. Attacking the obesity epidemic: the potential health benefits of providing nutrition information in restaurants. *Am J Public Health.* 2006 Sep;96(9):1669-1675.

20. Campos S, Doxey J, Hammond D. Nutrition labels on pre-packaged foods: a systematic review. *Public Health Nutrition*. 2011;14(8):1496-506.

21. Ayala C, Tong X, Valerrama A, Ivy A, Keenan N. Actions taken to reduce sodium intake among adults with self-reported hypertension: HealthStyles survey, 2005 and 2008. *Journal of Clinical Hypertension (Greenwich)*. 2010;12(10):793-9.

22. U.S. Census Bureau (2015). American Community Survey. *State & City Quickfacts: Boston, MA, Harford, CT, Springfield, MA, Providence, RI.* Retrieved from http://quickfacts.census.gov

23. Block JP, Condon SK, Kleinman K, Mullen J, Linakis S, Rifas-Shiman S, Gillman MW. Consumers' estimation of calorie content at fast food restaurants: cross sectional observation study. *BMJ*. 2013;346:f2907.
24. Urban LE, McCrory MA, Dallal GE. Accuracy of state energy contents of restaurant foods. *JAMA*. 2011;206(3):287-93.
25. Fitzpatrick L, Arcand J, L'Abbe M, Deng M, Duhaney T, Campbell N. Accuracy of Canadian food labels for sodium content of food. *Nutrients*. 2014;6(8);3326-35.
26. U.S. Department of Health and Human Services and U.S. Department of Agriculture. *2015-2020 Dietary Guidelines for Americans.* 8th Edition. December 2015. http://health.gov/dietaryguidelines/2015/guidelines/. Accessed August 29, 2016.
27. Scourboutakos MJ, Corey PN, Mendoza J, Henson SJ, L'Abbe MR. Restaurant menu labeling: is it worth adding sodium to the label? C*an J Public Health.* 2014 Jul 31;105(5):e354-e361.
28. Jackson SL, Coleman King SM, Park S, Fang J, Odom EC, Cogswell ME. Health professional advice and adult action to reduce sodium intake. *Am J Prev Med*. 2016;50(1):30-9.
29. Consumer sodium research: concern, perceptions, and action. Washington, DC: International Food Information Council. http://www.foodinsight.org. Published 2011. Accessed January 17, 2016.
30. Dunkin' Donuts website. www.dunkindonuts.com. Accessed January 17, 2016.
31. Oh A, Nguyen AB, Patrick H. Correlates of reported use and perceived helpfulness of calorie information in restaurants among U.S. adults. *Am J Health Promo*t. 2015 Jul 9.

32. Brown IJ, Tzoulaki I, Candeias V, Elliott P. Salt intakes around the world: implications for public health. *Int J Epidemiol.* 2009 Jun;38(3):791-813.

Chapter 3: Child and adolescent beverage purchases at the 76 largest U.S. chain restaurants

Alyssa J. Moran, S.V. Subramanian, Eric B. Rimm, Sara N. Bleich

Abstract

Importance: Restaurants play a significant role in promoting youth sugar-sweetened beverage (SSB) consumption. No studies have described what children and adolescents purchase at chain restaurants, nor assessed restaurant contextual correlates of SSB purchases.

Objectives: 1) To describe characteristics of beverages purchased for or by youth in the leading U.S. chain restaurants; 2) to identify predictors of purchases; and 3) to examine differences by household SES.

Design: Survey-weighted regression analyses based on 7-day food acquisitions conducted in 2017-2018.

Setting: Nationally representative data from the 2012-2013 U.S. Department of Agriculture National Household Food Acquisition and Purchase Survey (FoodAPS).

Participants: Household purchases made at the 76 top-earning chain restaurants that contained a beverage and were consumed by at least one child aged 2-18 years (n=1,567).

Main Outcomes and Measures: Whether an SSB (soda, fruit drink, sports/energy drink, or tea) or a healthy beverage (water, seltzer, or unsweetened milk) was included in the purchase, whether a beverage was purchased from the kids' menu, and per capita beverage calories (kcals) and sugar (g) per purchase.

Results: Overall, 65% of youth purchases included a beverage and 76% of beverage purchases included an SSB. Most beverages (82%) were purchased at fast-food restaurants, 43% were part of a combination meal, and 6% were from the kids' menu. Compared to purchases at fast-food restaurants, purchases at fast-casual (OR=0.4; 95% CI=0.2, 0.9) or full-service restaurants (0.2; 0.1, 0.5) were less likely to contain an SSB. Beverages purchased as part of a combination meal were 1.9 times more likely (1.2, 2.9) to include an SSB compared to beverages purchased as

single items. Beverages purchased by adolescents in the lowest income households contained significantly more calories and sugar per capita than those purchased by adolescents in the highest income households (348 kcals vs. 254 kcals and 74 g vs. 58 g).

Conclusions: Beverage purchases consumed by youth and purchased at fast-food restaurants or as part of a combination meal are more likely to contain SSBs. Policy and programmatic efforts to reduce youth purchases of SSBs in chain restaurants, particularly in fast-food restaurants, may reduce consumption and socioeconomic inequities.

Introduction

Sugar-sweetened beverage (SSB) consumption is a pervasive public health problem that threatens long-term health equity among U.S. children and adolescents. On a typical day, nearly two-thirds of youth aged 2-19 years consume at least one SSB, with sweetened beverage intake accounting for 7% of daily calories.[1,2] There are substantial disparities in SSB consumption by child race, ethnicity, and socioeconomic status (SES).[3,4] More Black and Mexican American youth consume SSBs than non-Hispanic White children.[2] Low-income children consume more daily calories from SSBs than high-income children, and are nearly twice as likely to be heavy consumers (≥500 kcals/day from SSBs).[4] These differences in consumption may widen persistent health disparities, as SSBs contribute substantially to daily calorie and added sugar intake[1] and have been linked to poor health outcomes, including increased risk of weight gain, metabolic dysfunction, dental caries, and early menarche in this age group.[5-11]

Restaurants play a significant role in promoting youth SSB consumption. Restaurants heavily advertise to children, spending more than half a billion dollars on child-directed advertising in 2009.[12] Each day, more than one-third of children and adolescents consume fast-food,[13] and on those days, they consume significantly more SSBs.[14] SSBs make up 80% of beverages offered on kids' menus at the leading chain restaurants,[15] and more than 10% of youth SSB calories come from fast-food restaurant sources.[16]

In recent years, restaurant industry pledges and local policies have sought to improve the nutritional quality of kids' meals, in part, through the promotion of healthy beverages. In 2011, the National Restaurant Association launched a voluntary program called Kids LiveWell, which set nutritional standards for kids' meals that over 150 chains in 42,000 locations have adopted.[17] Since 2013, many of the nation's leading chains have independently pledged to improve beverage options available to children by removing regular soda from kids' menu boards or offering healthier beverage options, like low-fat milk or water, automatically with kids' meals instead of an SSB.[18] In 2010, Santa Clara County adopted an ordinance prohibiting restaurants from distributing promotional toys or other child-focused incentives with items sold to kids aged 0-12 years and not meeting certain nutritional guidelines.[19] One year later, San Francisco enacted a similar policy.[20] Since 2015, a growing number of localities in California (e.g., Stockton, Davis, Perris, Berkeley, Santa Clara County) as well as other cities and counties (e.g., Baltimore, MD and Lafayette, CO) have adopted healthy default beverage policies, which require restaurants to offer healthy beverages, instead of SSBs, with children's meals.[21,22]

In response to these voluntary and regulatory actions, there is a need for better public health surveillance to understand youth restaurant purchases. To date, little research has described beverage choices made by youth at the national level, and published studies have largely relied on data collected from small samples of restaurants in one or a few states.[23,24] This study aims to fill these research gaps by using data collected from a nationally representative sample of households, to:

1. Describe characteristics of beverages purchased for or by youth in the leading 76 U.S. chain restaurants, overall and by household SES; and
2. Identify individual, household, and restaurant contextual correlates of youth beverage purchases.

Methods

Data

This study used data from the U.S. Department of Agriculture's National Household Food Acquisition and Purchase Survey (FoodAPS). FoodAPS is a nationally representative survey of U.S. households (n=4,826) with detailed information on all foods and beverages purchased by each individual in the household (n=14,317) over seven consecutive days.[25] Households were surveyed between April 2012 and January 2013, selected using a multi-stage sampling design, and stratified by participation in the Supplemental Nutrition Assistance Program (SNAP) – a program that provides nutrition assistance to low-income families – and household income. The primary respondent completed two in-person interviews and up to three telephone interviews, reporting on sociodemographic characteristics of people in the household, available financial resources, and foods acquired. All individuals in the household 11 years of age and older tracked detailed information about food acquisitions and indicated purchases consumed, using food records, scanned barcodes on foods, and receipts. Purchases of children under 11 years of age were recorded by the primary respondent. Participants were instructed to differentiate between food-at-home (e.g., supermarkets, farmers' markets, convenience stores) and food-away-from-home (FAFH; e.g., workplaces, schools, restaurants) purchases. FAFH constituted 39,120 purchases (71%) from 4,352 households, and one-quarter (25%) of these purchases occurred in the 78 top chain restaurants (list combined restaurants in Menustat with the top 30 fast-food and casual dining restaurants as ranked by *Quick Service Restaurant* and *Restaurant and Institutions* in 2009).[25]

Measures

The primary units of observation were restaurant purchases including a beverage, where the purchase was consumed by at least one child aged 2-18 years. Individual and household characteristics were obtained from interviews with the primary respondent and included the age (adult >18 years, adolescent 11-18 years, child 5-10 years, or young child 2-4 years), sex (male or female), race (White, Black, or other race), ethnicity (Hispanic or Non-Hispanic), and BMI (not overweight, overweight, obese) of the person acquiring the purchase; number of people sharing the purchase; age of the child consuming the purchase; household participation in SNAP (yes/no) or WIC (yes/no), food security status (food secure, marginal, low, or very low food security), poverty status (<100% FPL, 100%-184% FPL, ≥185% FPL), and educational attainment of the household primary respondent (<high school, high school graduate, > high school). SNAP and WIC participation were defined as current participation and ascertained primarily through administrative matching (SNAP) or self-report (WIC). Racial and ethnic groups were selected based on high consumption of SSBs among Black and Hispanic compared to White youth.[2]

Information about each purchase included the timing of the meal (breakfast, lunch, dinner, snack); whether it was intended for multiple meals; the number of items included in the purchase; and whether beverages were purchased from the kids' menu (defined as the item unit or relative size containing the word "kids"), as part of a combination meal, from a buffet, or as single items. Beverages were coded in FoodAPS into mutually exclusive categories based on the USDA food codes, and collapsed or further divided into categories by researchers **(Table 3.1)**. SSBs included sweetened soft drinks, sport/energy drinks, fruit drinks, sweetened teas, and flavored waters. "Healthy beverages" were defined as unsweetened water, seltzer, or milk, in concordance with healthy default beverage policies.[21,22] Beverage size, quantity, and description were self-reported and matched to nutrients (calories, sugar) and weight (g) from the Food and Nutrient Database for Dietary Studies in FoodAPS. FoodAPS provided a conversion factor to convert beverage grams to fluid ounces, but data on gram weight was more complete (one 20-oz soda is approximately 496 g, and a 20-oz water is 590 g).[26] For each purchase, researchers calculated per capita beverage grams, calories, and sugar by dividing total beverage weight and nutrients by the number of people who shared the meal. Characteristics of the restaurant from where the meal was purchased were coded by researchers based on classifications used in prior studies, and included information about whether the restaurant was fast-food (e.g., McDonald's), fast-casual (e.g., Panera Bread), or full-service (e.g., Chili's).[15,27-33]

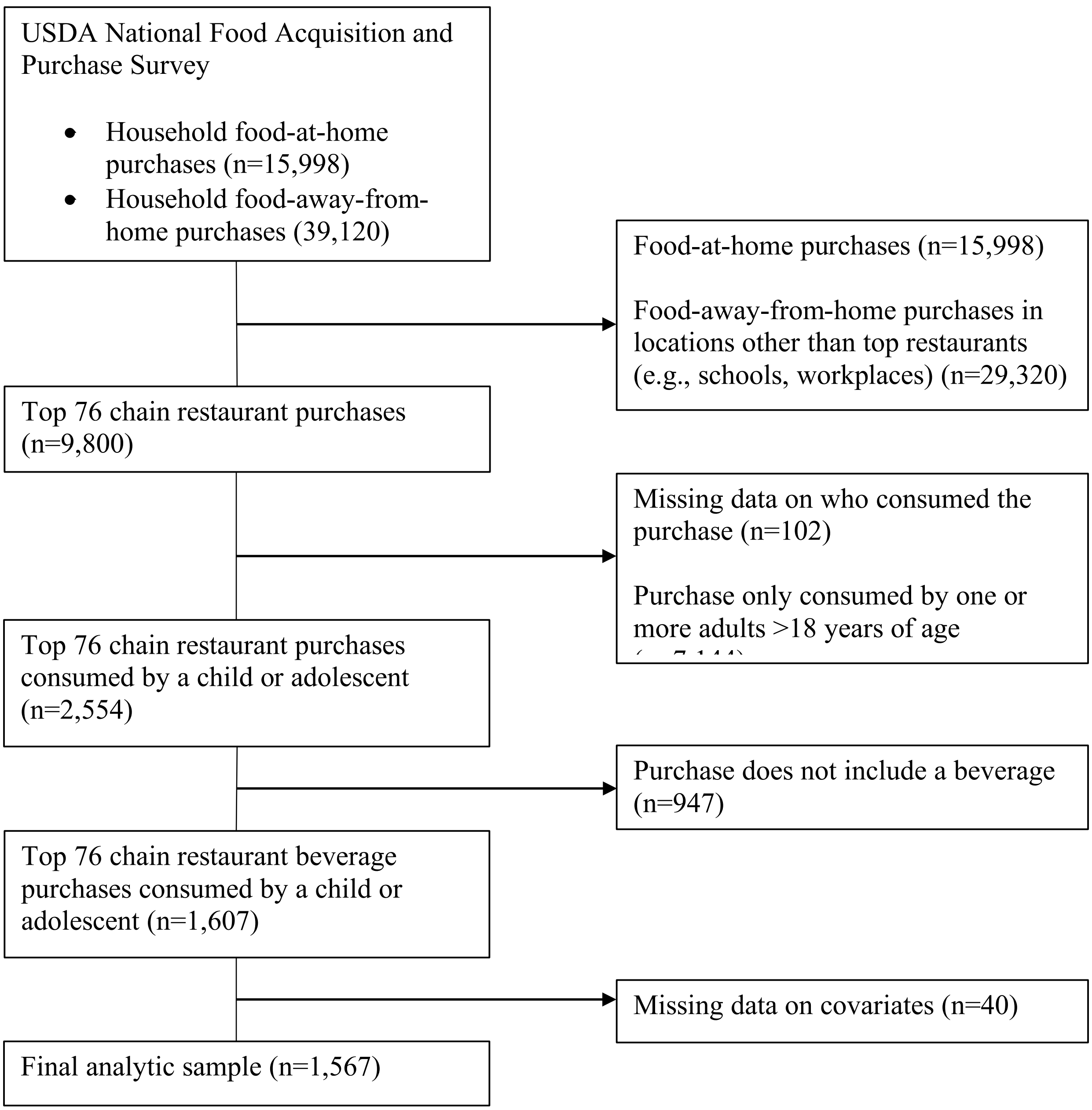
Table 3.1 Beverage coding

Beverage Type	**USDA Food Codes (Value Description)**	**Sugar Threshold Per 100g**
Sweetened beverages	72 (Sweetened beverages)	--
	7304 (Tea)	>4[a]
	78 (Flavored or enhanced water)	>2[b]
Soft drinks	7202 (Soft drinks)	--
Fruit drinks	7204 (Fruit drinks)	--
Sport / energy drinks	7206 (Sport and energy drinks)	--
Iced teas	7304 (Tea)	>4[a]
Flavored milk	12 (Flavored milk)	--
Milkshakes*	1402 (Milk shakes and other dairy drinks)	--
Sweetened coffee and coffee drinks	7302 (Coffee)	>4[a]
100% juice	70 (100% juice)	--
Diet beverages*	71 (Diet beverages)	--
Unsweetened coffee and tea*	73 (Coffee and tea)	≤4[a]
Water or seltzer	77 (Plain water)	
	78 (Flavored or enhanced water)	≤2[b]
Plain milk	10 (Milk)	

Note: Added sugar thresholds were used to separate sweetened from unsweetened coffee, tea, and flavored water.
[a] Threshold was chosen based on the amount of sugar in 1 teaspoon or 1 sugar packet.
[b] Threshold was chosen to separate sweetened enhanced water (i.e., Vitamin Water) from unsweetened waters and seltzers.

Of 9,800 FAFH purchases in the top chain restaurants, 102 (1%) were excluded for lacking information about who consumed the meal. Purchases consumed only by adults >18 years of age (n=7,144) and purchases by youth that did not include a beverage (n=947) were excluded. Of the remaining 1,607 beverage purchases consumed by youth, 40 (2.5%) were excluded for missing data on covariates, primarily data on BMI. Beverages were not purchased for youth from two of the 78 restaurants. This complete case analysis included a sample of 1,567 purchases containing a beverage from the leading 76 chain restaurants that was consumed by a child or adolescent (**Figure 3.1)**.

Figure 3.1 Sample selection flow chart



Statistical Analysis

Analyses were conducted in Stata Version 14 (College Station, TX) in 2017-2018, using survey procedures to account for the complex sampling design (clusters, strata, and household weights). To describe characteristics of child restaurant beverage purchases overall and by household income, survey-weighted means and frequencies were calculated. Simple linear regression and chi-square tests were used to compare differences across income groups. Multiple logistic regression was used to assess the odds and predicted probabilities of purchasing an SSB, a healthy beverage, or a beverage from the kids' menu. The primary independent variable was child age group and the primary dependent variables were binary measures for whether the purchase included an SSB, healthy beverage, or beverage on the kids' menu ("kids' beverage"), respectively. Lastly, multiple linear regression was used to examine correlates of calories and sugar from beverages among purchases including a caloric beverage. The primary independent variables were per capita beverage calories and sugar per purchase. Dependent variables included age of the child who consumed the purchase, characteristics of the person acquiring the purchase (age group, sex, race, ethnicity, BMI), characteristics of the household (educational attainment of the primary respondent, poverty status, food security status, participation in SNAP or WIC), and characteristics of the purchase (timing of purchase, whether it was intended for multiple meals, restaurant type, combination meal, kids' menu, or buffet). Stratified analyses by child age were also conducted. All multiple regressions controlled for the variables just mentioned, and logistic regressions additionally controlled for the total number of items purchased and whether the purchase was shared with other people. All analyses were weighted to be representative of the U.S. population, and robust variance was estimated using Taylor linearization. Results shown in tables and figures represent predicted means and probabilities from regression analyses. Significance was assessed at $p<0.05$.

Results

Overall, 65% of purchases at the 76 top chain restaurants consumed by youth included a beverage, and 76% of beverage purchases included an SSB (**Table 3.2**). The majority of beverages (82%) were purchased at fast-food restaurants, with more than one-third (37%) coming from one fast-food chain. Nearly half (43%) of beverages were purchased as part of a combination meal, and 6% were purchased from the kids' menu. More than half (55%) of beverages from the kids' menu were purchased from one fast-food chain.

Table 3.2 Characteristics of beverage purchases made for or by youth at the leading 76 U.S. chain restaurants in 2012-2013

			Household Income		
		Overall	<100% FPL	100%-184% FPL	185%+ FPL
Variable	N	% (SE)	% (SE)	% (SE)	% (SE)
Person in household who acquired purchase					
Adult (>18 years)	1,567	70.9 (2.7)	67.7 (5.0)	62.7 (4.8)	73.4 (3.3)
Adolescent (11-18 years)	1,567	27.0 (2.9)	26.9 (5.3)	33.8 (4.6)	25.3 (3.6)
Child (5-10 years)	1,567	1.7 (0.4)	4.0 (1.7)	1.9 (0.8)	1.3 (0.6)
Young child (2-4 years)	1,567	**0.4 (0.2)***	**1.4 (0.7)**	**1.6 (1.2)**	**0 (0)**
Beverage type					
Sweetened beverages	1,567	75.6 (2.2)	78.0 (2.7)	76.9 (3.3)	74.9 (2.7)
Soft drinks	1,187	71.3 (2.7)	74.4 (6.2)	72.3 (4.7)	70.6 (3.1)
Fruit drinks	1,187	18.3 (2.5)	18.4 (5.7)	15.8 (3.4)	19.0 (2.7)
Sport / energy drinks	1,187	1.8 (0.6)	1.9 (1.3)	1.2 (0.6)	1.9 (0.9)
Sweetened tea	1,187	26.6 (3.5)	14.9 (3.0)	29.0 (6.4)	27.9 (3.8)
Flavored milk	1,567	3.2 (0.7)	2.5 (1.0)	3.2 (1.0)	3.3 (1.0)
Milkshakes	1,567	**3.4 (0.7)***	**1.4 (0.9)**	**1.2 (0.6)**	**4.2 (0.9)**
Sweetened coffee and coffee drinks	1,567	2.7 (0.5)	2.4 (1.1)	3.6 (1.6)	2.5 (0.7)
100% juice	1,567	7.3 (1.0)	11.6 (2.3)	9.2 (2.5)	6.2 (1.3)
Diet beverages	1,567	**10.4 (1.5)***	**4.1 (1.3)**	**9.6 (2.2)**	**11.5 (1.9)**

(Table 3.2, continued)

Unsweetened coffee and tea	1,567	**9.1 (1.3)***	**2.8 (1.0)**	**9.7 (2.3)**	**9.9 (1.6)**
Water or seltzer	1,567	9.7 (1.2)	5.6 (2.1)	6.5 (1.7)	11.2 (1.7)
Plain milk	1,567	**2.8 (0.8)***	**1.4 (0.9)**	**0.7 (0.4)**	**3.5 (1.2)**
Beverage amount per capita, mean (SE)					
Weight (g)	1,567	**530.8 (17.0)***	**487.5 (22.0)**	**563.8 (27.3)**	**529.1 (20.9)**
Calories (kcals)	1,567	178.9 (7.8)	189.0 (9.8)	186.7 (13.3)	175.4 (9.9)
Sugar (g)	1,567	40.2 (1.7)	42.0 (1.9)	43.0 (3.2)	39.3 (2.2)
Timing of purchase					
Breakfast	1,567	12.3 (1.0)	8.5 (1.8)	12.0 (2.9)	12.9 (1.2)
Lunch	1,567	36.1 (2.3)	43.8 (4.3)	36.5 (2.7)	34.8 (3.1)
Dinner	1,567	41.6 (2.0)	38.9 (4.8)	42.3 (3.4)	41.9 (2.1)
Snack		11.3 (1.3)	9.8 (2.2)	9.6 (2.1)	11.9 (1.8)
Purchase location					
Fast-food restaurant	1,567	**81.9 (1.4)*****	**91.8 (1.9)**	**85.2 (2.1)**	**79.6 (1.7)**
Fast-casual restaurant	1,567	**6.1 (1.3)***	**2.2 (1.1)**	**4.1 (1.3)**	**7.2 (1.7)**
Full-service restaurant	1,567	**12.0 (1.2)***	**6.0 (1.5)**	**10.6 (1.6)**	**12.0 (1.2)**
National chain	1,567	89.1 (1.2)	89.2 (2.2)	87.0 (3.0)	89.6 (1.3)
Top-3 chains					
Burger chain 1	1,567	36.9 (2.3)	41.2 (3.4)	41.4 (4.2)	35.0 (2.8)
Burger chain 2	1,567	**5.7 (0.8)****	**14.1 (4.4)**	**5.8 (1.2)**	**4.4 (1.1)**
Sandwich chain 1	1,567	5.2 (0.8)	3.2 (1.4)	4.2 (0.9)	5.7 (1.1)
Purchase included items from…					
Combination meal	1,567	42.6 (2.3)	45.7 (3.5)	50.2 (3.6)	40.3 (3.3)
Buffet	1,567	0.9 (0.5)	0 (0)	0.5 (0.5)	1.1 (0.7)
Kids' menu	1,567	5.8 (1.3)	5.7 (1.4)	5.4 (1.5)	5.9 (1.8)
Purchase consumption					
Intended for multiple meals	1,567	0.9 (0.4)	0.9 (0.4)	0.4 (0.2)	1.0 (0.6)
Consumed solely by one child	1,567	20.0 (2.5)	19.2 (3.3)	26.9 (3.5)	18.4 (3.4)
Shared with other people (household or others)	1,567	80.0 (2.5)	80.8 (3.3)	73.1 (3.5)	81.7 (3.4)
Number of people who shared, mean (SE)	1,567	2.5 (0.1)	2.5 (0.1)	2.5 (0.2)	2.5 (0.1)
Consumed by a young child (2-4 years)	1,567	20.9 (1.9)	21.0 (3.6)	25.9 (3.4)	19.6 (2.6)
Consumed by a school-aged child (5-10 years)	1,567	34.2 (3.4)	39.2 (6.0)	27.2 (4.5)	35.1 (4.2)
Consumed by an adolescent (13-18 years)	1,567	59.4 (3.3)	55.1 (4.7)	65.9 (4.3)	58.5 (4.5)

Note: Chi-square tests and regressions assessed differences between groups for categorical and continuous variables, respectively. Percentages listed for beverage type and sugar-sweetened beverage type do not add to 100 because purchases could contain more than one beverage and more than one sugar-sweetened beverage. Standard errors account for complex survey design (strata, cluster, and household weights). Boldface indicates statistically significant differences across rows. *p<0.05; **p<0.01; ***p<0.001

The probability of purchasing a sweetened beverage or healthy beverage did not differ by any individual or household characteristics, except that households with the highest educational attainment were 4.3 times more likely to choose a healthy beverage than those with the lowest educational attainment (95% CI=1.4, 12.9) (**Table 3.3**).

Table 3.3 Odds and predicted probabilities of youth beverage purchases at the leading 76 U.S. chain restaurants in 2012-2013

Variable	**Purchase includes sweetened beverage**		**Purchase includes healthy beverage**		**Purchase includes kids' beverage**	
	OR (95% CI)	Predicted Probability (%)	OR (95% CI)	Predicted Probability (%)	OR (95% CI)	Predicted Probability (%)
Characteristics of child who consumed						
Young child (2-4)						
No	ref	76.7	ref	11.1	ref	5.0
Yes	0.7 (0.3, 1.7)	70.9	1.6 (0.9, 2.9)	15.8	1.7 (0.5, 5.5)	7.5
Child (5-10)						
No	ref	77.1	ref	11.3	ref	5.2
Yes	0.7 (0.3, 1.5)	72.2	1.3 (0.5, 3.4)	13.5	1.3 (0.4, 4.2)	6.5
Adolescent (11-18)						
No	ref	74.1	ref	11.8	ref	7.7
Yes	1.2 (0.5, 2.6)	76.5	1.0 (0.4, 2.6)	12.1	**0.4 (0.2, 0.8)***	3.5
Characteristics of person who purchased						
Age						
Adult (>18 years)	ref	74.5	ref	10.5	ref	6.4
Adolescent (11-18 years)	1.3 (0.6, 2.9)	78.1	2.1 (0.9, 4.9)	17.8	0.4 (0.1, 1.2)	2.9
Child (5-10 years)	1.6 (0.3, 8.7)	80.6	0.2 (0.0, 2.3)	3.4	**0.0 (0.0, 0.4)****	0.3
Sex						
Male	ref	77.2	ref	9.7	ref	6.2
Female	0.8 (0.5, 1.3)	74.7	1.5 (0.8, 3.1)	13.2	0.9 (0.3, 2.9)	5.7
Race						
White	ref	75.2	ref	11.7	ref	4.6
Black	1.1 (0.6, 2.0)	76.9	1.7 (0.7, 4.5)	17.2	**3.1 (1.4, 7.1)****	10.9
Other race	1.0 (0.6, 1.8)	75.7	0.7 (0.3, 1.5)	9.0	1.5 (0.8, 2.9)	6.4
Hispanic						
No	ref	74.6	ref	12.5	ref	5.8
Yes	1.6 (0.9, 2.9)	81.1	0.5 (0.2, 1.3)	7.9	0.9 (0.4, 2.4)	5.5
BMI category						
Not overweight	ref	73.1	ref	13.0	ref	8.4

(Table 3.3, continued)

Overweight	1.5 (0.9, 2.5)	78.7	1.0 (0.5, 2.2)	13.0	**0.4 (0.2, 0.8)***	3.7
Obese	1.2 (0.8, 2.0)	76.3	0.6 (0.3, 1.2)	9.1	0.5 (0.2, 1.1)	4.8
Characteristics of household						
Educational attainment of primary respondent						
<High School	ref	71.0	ref	4.0	ref	4.3
High School Grad	1.6 (0.6, 3.9)	77.6	3.4 (0.9, 12.7)	10.8	0.9 (0.2, 3.4)	3.9
>High School	1.3 (0.7, 2.7)	75.5	**4.3 (1.4, 12.9)***	12.8	1.7 (0.5, 5.4)	6.4
Poverty status						
185%+ FPL	ref	76.4	ref	12.3	ref	7.0
100%-184% FPL	0.8 (0.5, 1.4)	73.7	0.7 (0.3, 1.4)	9.2	0.4 (0.2, 1.3)	3.7
<100% FPL	0.8 (0.4, 1.4)	72.7	1.3 (0.5, 3.6)	14.8	0.5 (0.1, 1.8)	4.2
Food security status of household						
Food secure	ref	75.3	ref	12.1	ref	3.8
Marginal food security	1.0 (0.6, 1.6)	75.2	1.0 (0.5, 2.1)	12.0	**2.4 (1.1, 5.5)***	7.8
Low food security	1.3 (0.5, 3.4)	79.2	1.1 (0.4, 3.2)	12.8	**4.9 (1.3, 18.0)***	12.9
Very low food security	0.9 (0.4, 2.2)	73.8	0.6 (0.2, 1.8)	8.3	**3.7 (1.3, 10.8)***	10.6
Food assistance participation						
SNAP						
No	ref	75.3	ref	12.6	ref	5.4
Yes	1.1 (0.6, 2.1)	76.9	0.5 (0.2, 1.3)	7.8	1.6 (0.6, 4.3)	7.7
WIC participant						
No	ref	75.2	ref	11.9	ref	6.1
Yes	1.4 (0.6, 3.2)	80.0	1.2 (0.7, 2.2)	13.6	0.5 (0.2, 1.1)	3.4
Purchase characteristics						
Restaurant type						
Fast-food	ref	78.8	ref	7.6	ref	5.3
Fast-casual	**0.4 (0.2, 0.9)***	65.9	**5.9 (3.5, 9.9)*****	29.3	2.2 (0.7, 7.3)	9.4
Full-service	**0.2 (0.1, 0.5)****	53.9	**4.1 (1.4, 12.7)***	23.3	1.4 (0.3, 6.0)	7.0
Combination meal						
No	ref	72.2	ref	13.9	ref	3.1
Yes	**1.9 (1.2, 2.9)****	81.4	**0.4 (0.2, 0.6)****	6.7	**3.5 (1.5, 8.2)****	8.8
Kids' menu						
No	ref	75.4	ref	12.2	--	--

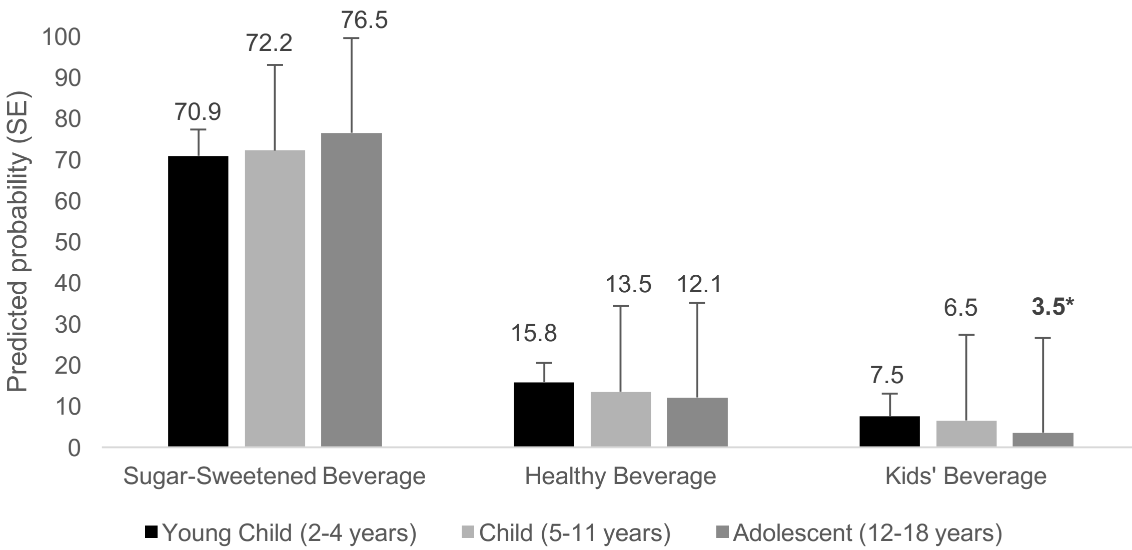
(Table 3.3, continued)

Yes	1.4 (0.5, 3.6)	79.8	0.6 (0.2, 2.2)	8.5	--	--

(Table 3.3 continued) Note: Logistic regressions additionally controlled for the number of items purchased, whether the purchase was shared with other people, whether the purchase was acquired by a young child (2-4 years old), the timing of the purchase (breakfast, lunch dinner, or snack) whether the beverage came from a buffet, and whether or not the purchase was intended for multiple meals. Predicted probabilities were calculated with covariates held at their means or reference groups. Standard errors account for complex survey design (strata, cluster, and household weights). Boldface indicates statistically significant difference from reference group. *p<0.05; **p<0.01; ***p<0.001

Compared to purchases at fast-food restaurants, purchases at fast-casual restaurants were 0.4 times as likely to include an SSB (0.2, 0.9) and purchases at full-service restaurants were 0.2 times as likely to include an SSB (0.1, 0.5). Purchases were 1.9 times more likely (1.2, 2.9) to include an SSB and 0.4 times as likely (0.2, 0.6) to include a healthy beverage if purchased as part of a combination meal vs. as a single item. Few purchases included kids' beverages, and the probability of ordering from the kids' menu declined as the age of the child consuming the purchase increased **(Figure 3.2).** The odds of purchasing a beverage from the kids' menu were 3.1 times higher when the purchase was made by a Black person vs. a White person (1.4, 7.1) and 4.9 times higher when the purchase was made by a household with low vs. high food security (1.3, 18.0).

Figure 3.2 Sugar-sweetened beverage, healthy beverage, and kids' beverage purchases at the 76 largest U.S. chain restaurants



Caption: Figure shows the predicted probability (SE) of a purchase including a sugar-sweetened beverage, healthy beverage (water, seltzer, or unsweetened milk), or a beverage from the kids' menu when consumed by a young child (vs. not consumed by a young child), a child (vs. not a child), or an adolescent (vs. not an adolescent). Data are from logistic regressions performed on purchases from the leading 76 chain restaurants that contain a beverage and were consumed by a child or adolescent in 2012-2013 (n=1,567). Regressions controlled for the age, sex, race, ethnicity, and BMI of the person who acquired the purchase, the educational attainment of the household primary respondent, poverty and food security status of the household, federal food assistance participation (SNAP and WIC), restaurant type (fast-food, full-service, or fast-casual), whether the purchase was selected as part of a combination meal or from a buffet, timing of the purchase, whether the purchase was shared, the number of items purchased, and whether the purchase was intended for multiple meals. Predicted probabilities were calculated with covariates

(Figure 3.2 continued) held at their means or reference groups. Standard errors account for complex survey design (strata, cluster, and household weights), so values are representative of the national population. Boldface indicates statistically significant difference from the reference group. *p<0.05

Purchases containing a caloric beverage contained fewer calories and grams of sugar per capita when consumed by a young child vs. not by a young child (158 kcals vs. 199 kcals and 36 g vs. 45 g, respectively) or by a child vs. not by a child (172 kcals vs. 200 kcals and 39 g vs. 45 g) (**Table 3.4**). Purchases contained more beverage calories and more sugar per capita when acquired by a Hispanic person (206 kcals vs. 187 kcals and 47 g vs. 42 g) or by an adolescent vs. an adult (241 kcals vs. 172 kcals and 55 g vs. 38 g).

Table 3.4 Correlates of mean beverage calories and sugar from youth beverage purchases at the leading 76 U.S. chain restaurants in 2012-2013

Variable	**Calories (kcals) per capita per purchase**	**Sugar (g) per capita per purchase**
	Predicted mean (95% CI)	Predicted mean (95% CI)
Characteristics of child who consumed		
Young child (2-4)		
No (ref)	199 (179, 218)	45 (40, 49)
Yes	**158 (140, 176)****	**36 (31, 40)****
Child (5-10)		
No (ref)	200 (180, 219)	45 (41, 49)
Yes	**172 (156, 188)****	**39 (35, 42)****
Adolescent (11-18)		
No (ref)	185 (166, 204)	41 (37, 46)
Yes	194 (175, 213)	44 (40, 48)
Characteristics of person who purchased		
Age		
Adult (>18 years) (ref)	172 (156, 188)	38 (35, 42)
Adolescent (11-18 years)	**241 (219, 263)*****	**55 (51, 59)*****
Child (5-10 years)	180 (133, 226)	42 (30, 53)
Sex		
Male (ref)	184 (159, 209)	42 (36, 47)
Female	193 (176, 210)	43 (40, 47)
Race		
White (ref)	191 (174, 209)	43 (39, 47)
Black	194 (160, 229)	44 (36, 52)
Other race	182 (162, 201)	41 (37, 45)
Hispanic		
No (ref)	187 (169, 205)	42 (38, 46)
Yes	**206 (186, 226)***	**47 (42, 51)***
BMI category		
Not overweight (ref)	198 (171, 226)	44 (39, 50)
Overweight	186 (170, 201)	42 (38, 46)
Obese	183 (168, 197)	41 (38, 44)
Characteristics of household		
Educational attainment of primary respondent		
<High School (ref)	170 (143, 198)	37 (31, 44)
High School Grad	197 (169, 225)	**44 (39, 50)***
>High School	191 (173, 208)	43 (39, 47)
Poverty status		
185%+ FPL (ref)	188 (169, 208)	42 (38, 46)
100%-184% FPL	191 (163, 218)	44 (37, 50)
<100% FPL	200 (173, 227)	44 (39, 50)
Food security status		

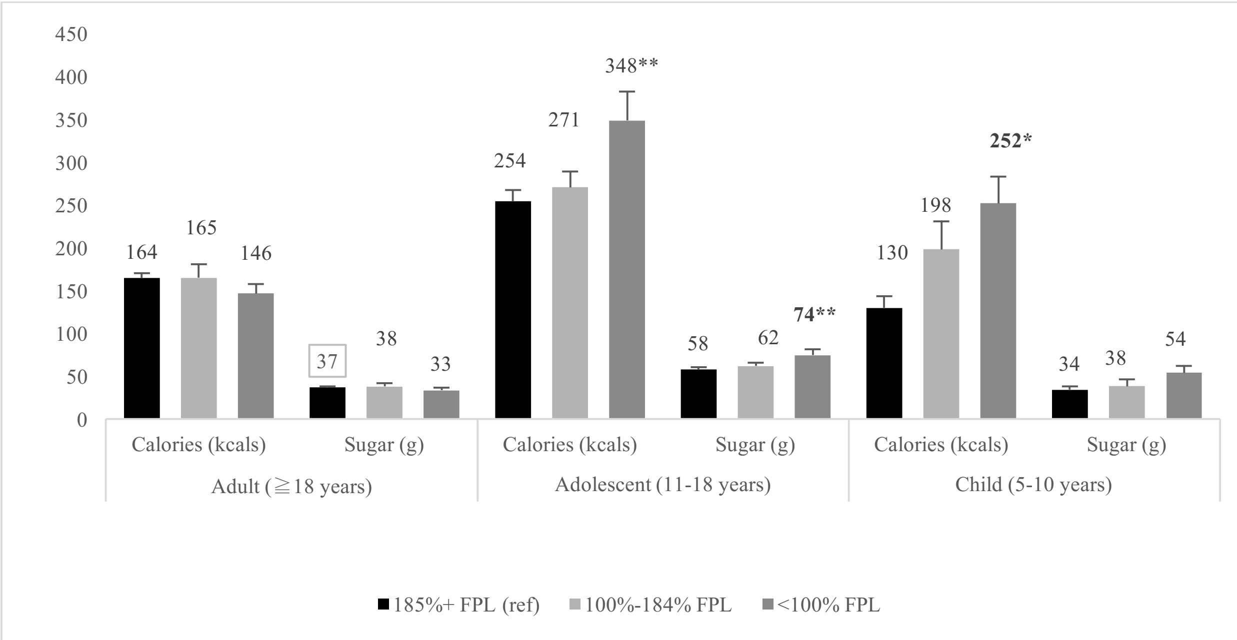
(Table 3.4, continued)

Food secure (ref)	196 (175, 216)	44 (40, 48)
Marginal food security	186 (167, 206)	42 (38, 47)
Low food security	178 (151, 204)	40 (34, 46)
Very low food security	174 (143, 205)	40 (33, 47)
Food assistance participation		
SNAP		
No (ref)	189 (172, 207)	43 (39, 46)
Yes	194 (168, 221)	44 (38, 49)
WIC participant		
No (ref)	190 (174, 205)	43 (39, 46)
Yes	197(166, 228)	43 (37, 50)
Purchase characteristics		
Restaurant type		
Fast-food (ref)	193 (176, 211)	44 (40, 47)
Fast-casual	180 (147, 213)	41 (34, 49)
Full-service	163 (119, 207)	**33 (24, 42)***
Combination meal		
No (ref)	187 (168, 206)	42 (37, 46)
Yes	194 (175, 213)	44 (40, 48)
Kids' menu		
No (ref)	190 (172, 207)	43 (39, 46)
Yes	197 (165, 228)	45 (36, 53)

Note: Limited to purchases including a caloric beverage. Logistic regression additionally controlled for whether the purchase was acquired by a young child (2-4 years old), the timing of the purchase (breakfast, lunch dinner, or snack) whether the beverage came from a buffet, and whether or not the purchase was intended for multiple meals. Standard errors account for complex survey design (strata, cluster, and household weights). Boldface indicates statistically significant difference from reference group. *$p<0.05$; **$p<0.01$; ***$p<0.001$

Purchases by adolescents in the lowest income households contained 348 kcals and 74 g sugar from beverages per capita, compared to 254 kcals and 58 g among adolescents in the highest income households ($p=0.008$ and 0.03, respectively). Purchases by children in the lowest income households contained 252 calories per capita, compared to 130 calories among children in the highest income households ($p=0.009$) (**Figure 3.3**).

Figure 3.3 Per capita beverage calories (kcals) and sugar (g) by age and household income



Caption: Figure shows the predicted mean (SE) beverage calories (kcals) and sugar (g) per capita among purchases acquired by adults, adolescents, and children by household income. Data are from linear regressions performed on purchases from the leading 76 chain restaurants that contain a beverage and were consumed by a child in 2012-2013 (n=999 for adults, n=435 for adolescents, and n=34 for children). Regressions controlled for the sex, race, ethnicity, and BMI of the person who acquired the purchase, the educational attainment of the household primary respondent, food security status of the household, federal food assistance participation (SNAP and WIC), restaurant type, whether the purchase was selected as part of a combination meal or from a buffet, timing of the purchase, whether the purchase was shared, the number of items purchased, and whether the purchase was intended for multiple meals. Standard errors account for complex survey design (strata, cluster, and household weights), so values are representative of the national population. Boldface indicates statistically significant difference from the reference group (185%+ FPL). *$p<0.05$, **$p<0.01$

Discussion

Findings from this large nationally representative weighted sample of food purchased away from home show that across income levels, children and adolescents acquire a substantial amount of sugar and calories from restaurant beverages, and that beverage choice is primarily driven by restaurant contextual factors, including restaurant type and promotions. More than three-quarters (76%) of restaurant beverage purchases consumed by youth contained an SSB, and beverages contributed an average of 179 calories and 40 grams of sugar per capita. SSBs were more likely to be purchased at fast-food compared to full-service restaurants, and beverages purchased as part of a combination meal were more likely to include an SSB than beverages purchased as single items. These results are similar to findings from a study of beverages purchased by parents for children in five fast-food restaurant chains in the Northeast,[23] and suggest that one strategy to reduce youth SSB consumption is to offer healthy beverages as the default in fast-food combination meals.

In this study, adolescents were more likely to purchase SSBs than adults, and low-income adolescents purchased more calories and sugar per capita than higher income adolescents. Adolescent purchases contained 69 more calories per capita than adult purchases (241 kcals vs. 172 kcals), which differs slightly from National estimates of consumption, in which adolescents ages 12-19 consume more daily calories from SSBs than older adults (40+ years) but less than young adults (20-39 years).[2] Adolescents in the lowest income households purchased 94 more calories and 16 more grams of sugar per capita from beverages than adolescents in the highest income category -- a difference that could be explained by adolescents trying to maximize their calories per dollar, or that may be related to fast-food marketing targeted towards lower income teens. In 2009, 36% of teen-directed food advertising was for fast-foods, and the majority of advertising dollars went towards nutrient-poor items.[12,34] McDonald's and Burger King, who are members of the Children's Food and Beverage Advertising Initiative (CFBAI), have pledged to reduce unhealthy food marketing to young children (≤11 years of age), but have made little effort to reduce marketing to older children (12+ years), who experienced a 23% increase in exposure to advertisements in the CFBAI's first five years.[35,36] Further, there are substantial disparities in adolescent advertising exposure by household income, with teens in the lowest income areas viewing relatively more television advertisements for unhealthy items, including fast-foods and SSBs, than healthy items, compared to teens in higher income areas.[37] Differential exposure to advertisements is particularly important in this age group because, physiologically, the adolescent brain may be more vulnerable to unhealthful food cues. The limbic system of the brain is not fully developed in adolescents, making them more likely to act on stimuli associated with pleasure and rewards,[38] like food-related images and commercials.[39-41]

Results from this study suggest that voluntary programs and policies targeting kids' meals touch only a small percentage of youth restaurant beverage purchases, but may disproportionately affect populations most likely to choose an SSB. Only 6% of beverage purchases came from the kids' menu, but this was more likely when purchases were consumed by a young child (compared to a teen), and when purchases were made by food insecure households.[2,42] If effective, voluntary pledges or local ordinances that remove SSBs from the kids' menus or promote healthy default beverage options could have positive implications for disparities; however, to date, studies have shown poor restaurant compliance with the intended effect of such program and policies, and their effects on SSB purchases have been modest, at best.[15,18,43-45] Healthy default beverage policies that apply to all combination meals purchased by children (kids' meals and "value" meals on the regular menu board) may ultimately be more impactful given that the vast majority of purchases for kids are from the adult menu.

This study adds to the literature by providing the first description of beverages purchased for or by youth in the leading U.S. chain restaurants. One limitation is the inability to link individual items in a purchase to the individual who consumed them. Per capita beverage calories and sugar were used as an estimate of consumption, but could be an overestimate, particularly if adults are purchasing larger beverages for themselves and smaller beverages for their children (this analysis calculated the average for the number of people who shared the meal). Availability may also overestimate consumption if not all beverages purchased are consumed; a plate waste study of children's purchases and consumption in fast-food restaurants found that kids aged 5-11 years drank 67% of beverages ordered, although this value may be higher for older children.[24] Food and beverage acquisitions were self-reported, which may induce social desirability bias and underreporting of beverages perceived as unhealthy, like SSBs. Item size, which was used to code beverages purchased from the kids' menu, was not recorded consistently by FoodAPS participants. However, reported items were matched to descriptions in Menustat, which allowed researchers to identify kids' menu items for 66 of the 76 restaurants included in the study. Additionally, BMI was self-reported for the primary respondent, and reported for other household members by proxy, which may increase random error and bias associations towards the null. Strengths of this study include a nationally representative sample of households oversampling low income households, data on purchases over seven days, and the inclusion of individual, household, and restaurant contextual characteristics in analyses.

Conclusions

Overall, the vast majority of youth beverage purchases at the leading U.S. chain restaurants included SSBs, and few purchases included healthful alternatives, such as water, seltzer, and unsweetened milk, coffee, or tea. Per capita beverage calories and sugar exceeded national recommendations, and were particularly high among purchases made by adolescents in the lowest income households. Restaurant contextual factors, specifically purchasing a beverage in a fast-food restaurant or as part of a combination meal, were more influential than individual or household characteristics on beverage choice. Policy and programmatic efforts to reduce youth purchases of SSBs in chain restaurants, particularly in fast-food restaurants, may reduce consumption and socioeconomic inequities.

References

1. Rosinger A, Herrick K, Gahche J, Park S. Sugar-sweetened beverage consumption among U.S. youth, 2011-2014. NCHS data brief, no. 271. Hyattsville, MD: National Center for Health Statistics; 2017.
2. Bleich SN, Vercammen KA, Koma JW, Li Z. Trends in beverage consumption among children and adults, 2003-2014. *Obesity (Silver Spring)*. 2017 [Epub ahead of print]
3. U.S. Department of Health and Human Services and U.S. Department of Agriculture. *2015-2020 Dietary Guidelines for Americans.* 8th Edition. December 2015. Available at http://health.gov/dietaryguidelines/2015/guidelines/.
4. Han E, Powell LM. Consumption patterns of sugar-sweetened beverages in the United States. *J Acad Nutr Diet.* 2013;113(1):43-53.
5. Malik VS, Pan A, Willett WC, Hu FB. Sugar-sweetened beverages and weight gain in children and adults: a systematic review and meta-analysis. *Am J Clin Nutr*. 2013 Oct;98(4):1084-102. doi:10.3945/ajcn.113.058362.
6. Hu FB. Resolved: there is sufficient scientific evidence that decreasing sugar-sweetened beverage consumption will reduce the prevalence of obesity and obesity-related diseases. *Obes Rev*. 2013 Aug;14(8):606-19.
7. Evens EW, Hayes C, Palmer CA, Bermudez OI, Cohen SA, Must A. Dietary intake and severe early childhood caries in low-income, young children. *J Acad Nutr Diet.* 2013;113:1057-1061.
8. Marshall TA, Levy SM, Broffitt B, Warren JJ, Eichenberger-Gilmore JM, Burns TL, et al. Dental caries and beverage consumption in young children. *Pediatrics*. 2003;112:e184-e191.

9. Carwile JL, Willett WC, Spiegelman D et al. Sugar-sweetened beverage consumption and age at menarche in a prospective study of US girls. *Hum Reprod*. 2015 Mar;30(3):675-83.
10. Hur YI, Park H, Kang JH, Lee HA, Song JH, Lee HJ, et al. Associations between sugar intake from different food sources and adiposity or cardio-metabolic risk in childhood and adolescence: the Korean child-adolescent cohort study. *Nutrients*. 2015 Dec 31;8(1).
11. Mirmiran P, Yuzbashian E, Asghari G, Hosseinpour-Niazi S, Azizi F. Consumption of sugar sweetened beverage is associated with incidence of metabolic syndrome in Tehranian children and adolescents. *Nutr Metab (Lond)*. 2015 Jul 30;12:25.
12. Federal Trade Commission. A review of Food Marketing to Children and Adolescents: Follow-Up Report. Federal Trade Commission; Washington DC: 2012. Available at: www.ftc.gov/os/2012/12/121221foodmarketingreport.pdf. Accessed December 23, 2017.
13. National Center for Health Statistics. Caloric intake from fast-food among children and adolescents in the United States, 2011-2012. www.cdc.gov/nchs/data/databriefs/db213.pdf. Published September 2015. Accessed October 21, 2015.
14. Powell LM, Nguyen BT. Fast-food and full-service restaurant consumption among children and adolescents: effect on energy, beverage, and nutrient intake. *JAMA Pediatr*. 2013;167(1):14-20.
15. Moran AJ, Block JP, Goshev SG, Bleich SN, Roberto CA. Trends in nutrient content of children's menu items in U.S. chain restaurants. *Am J Prev Med*. 2017;52(3):284-291.
16. Poti JM, Slining MM, Popkin BM. Where are kids getting their empty calories? Stores, schools, and fast food restaurants each play an important role in empty calorie intake among US children in 2009-2010. *J Acad Nutr Diet.* 2014;114(6):908-917.

17. National Restaurant Association. Kids LiveWell website. www.restaurant.org/Industry-Impact/Food-Healthy-Living/Kids-LiveWell/About. Accessed December 26, 2017.
18. Harris J, Hyary M, Seymour N, Choi Y. Are Fast-Food Restaurants Keeping Their Promises to Offer Healthier Kids' Meals? August 2017.
19. Yeager Ken, Santa Clara County Board of Supervisors. An ordinance of the board of supervisors of the County of Santa Clara adding chapter XXII of division A18 to the County of Santa Clara ordinance code relating to toys and other incentives with restaurant food.
20. Mar E, Campos D, Chiu D, Avalos J. Health code -- setting nutritional standards for restaurant food sold accompanied by toys or other youth focused incentive items. Enactment no. 290 -- 10. San Francisco Board of Supervisors; November 23, 2010.
21. Wood, Cirrus. Berkeley requires kids' meals to include milk or water, not soda. *Nosh*. August 10, 2017. Available: http://www.berkeleyside.com/2017/08/10/berkeley-requires-kids-meals-include-milk-water-not-soda/. Accessed January 3, 2018.
22. County of Santa Clara, County News. Santa Clara County restricts availability of sugar sweetened beverages. April 26, 2017. Available: https://www.sccgov.org/sites/opa/nr/Pages/Restrictions-on-sugar-sweetened-beverages-in-children's-meals.aspx. Accessed January 3, 2018.
23. Cantor J, Breck A, Elbel B. Correlates of sugar-sweetened beverages purchased for children at fast-food restaurants. *Am J Public Health*. 2016;106(11):2038-2041.
24. Cohen JF, Roberts SB, Anzman-Frasca S, Gamache MM, Lynskey VM, Matthews E, et al. A pilot and feasibility study to assess children's consumption in quick-service restaurants using plate waste methodology. *BMC Public Health*. 2017 Mar;17(10):259.

25. Economic Research Service (ERS), U.S. Department of Agriculture (USDA). National Household Food Acquisition and Purchase Survey (Foodaps). http://www.ers.usda.gov/foodaps.

26. Aqua-calc conversions and calculations. Available: http://www.aqua-calc.com. Accessed January 5, 2018.

27. Bleich SN, Wolfson JA, Jarlenski MP, Block JP. Restaurants with calories displayed on menus had lower calorie counts compared to restaurants without such labels. *Health Aff (Millwood)*. 2015 Nov;34(11):1877-84.

28. Bleich SN, Wolfson JA, Jarlenski MP. Calorie changes in large chain restaurants: declines in new menu items but room for improvement. *Am J Prev Med*. 2016 Jan;50(1):e1-e8.

29. Jarlenski MP, Wolfson JA, Bleich SN. Macronutrient composition of menu offerings in fast food restaurants in the U.S. *Am J Prev Med.* 2016 Oct;51(4):e91-7.

30. Bleich SN, Wolfson JA, Jarlenski MP. Calorie changes in large chain restaurants from 2008 to 2015. *Prev Med*. 2017 Jul;100:112-116.

31. Bleich SN, Moran AJ, Jarlenski MP, Wolfson JA. Higher-calorie menu items eliminated in large chain restaurants. *Am J Prev Med*. 2017 Dec 6 [Epub ahead of print]

32. Wolfson JA, Moran AJ, Jarlenski MP, Bleich SN. Trends in sodium content of menu items in large chain restaurants in the U.S. *Am J Prev Med*. 2018 Jan;54(1):28-36.

33. Bleich SN, Wolfson JA, Jarlenski MP. Calorie changes in chain restaurant menu items: implications for obesity and evaluations of menu labeling. *Am J Prev Med*. 2015 Jan;48(1):70-5.

34. Powell LM, Schermbeck RM, Szczypka G, Chaloupka FJ, Braunschweig CL. Trends in the nutritional content of television food advertisements seen by children in the United States: analyses by age, food categories, and companies. *Arch Pediatr Adolesc Med*. 2011;165:1078-1086.

35. Harris JL, Heard A, Schwartz MB. Older but still vulnerable: all children need protection from unhealthy food marketing [2014]. Yale Rudd Center. http://www.uconnruddcenter.org/files/Pdfs/Protecting_Older_Children_3_14.pdf. Accessed January 7, 2018.

36. Grow HM, Schwartz MB. Food marketing to youth: serious business. *JAMA*. 2014;312(18):1918-1919.

37. Powell LM, Wada R, Kumanyika SK. Racial/ethnic and income disparities in child an adolescent exposure to food and beverage television ads across U.S. media markets. *Health Place*. 2014;29:124-131.

38. Arain M, Haque M, Johal L, Mathur P, Nel W, Rais A, et al. Maturation of the adolescent brain. *Neuropsychiatr Dis Treat.* 2013;9:449-461.

39. Gearhardt AN, Yokum S, Stice E, Harris JL, Brownell KD. Relation of obesity to neural activation in response to food commercials. *Soc Cogn Affec Neurosci.* 2014;9(7):932-8.

40. Demos KE, Heatherton TF, Kelley WM. Individual differences in nucleus accumbens activity to food and sexual images predict weight gain and sexual behavior. *J Neurosci*. 2012;32:5549-5552. Stice E, Yokum S, Bohon C, Marti N, Smolen A. Reward circuitry responsivity to food predicts future increases in body mass: moderating effects of DRD2 and DRD4. *Neuroimage*. 2010;50:1618-1625.

41. Yokum S, Gearhardt AN, Harris JL, Brownell KD, Stice E. Individual differences in striatum activity to food commercial predict weight gain in adolescents. *Obesity (Silver Spring)*. 2014 Dec;22(12):2544-2551.

42. Leung CW, Epel ES, Ritchie LD, Crawford PB, Laraia BA. Food insecurity is inversely associated with diet quality of lower-income adults. *J Acad Nutr Diet.* 2014 Dec;114(12):1943-53.

43. Otten JJ, Hekler EB, Krukowski RA, Buman MP, Saelens BE, Gardner CD, King AC. Food marketing to children through toys: response of restaurants to the first U.S. toy ordinance. *Am J Prev Med*. 2012 Jan;42(1):56-60.

44. Otten JJ, Saelens BE, Kapphahn KI. Hekler EB, Buman MP, Goldstein BA, et al. Impact of San Francisco's toy ordinance on restaurants and children's food purchases, 2011-2012. *Prev Chron Dis.* 2014;11:E122.

45. Anzman-Frasca S, Mueller MP, Sliwa S, Dolan PR, Harelick L, Roberts SB, Washburn K, Economos CD. Changes in children's meal orders following healthy menu modifications at a regional U.S. restaurant chain. *Obesity*. 2015;23:1055-1062.