Public Health Nutrition: 23(16), 2857–2863 doi:10.1017/S136898002000110X

Short Communication

Differences in the sugar content of fast-food products across three countries

Nicole Lewis[1], Qiushi Huang[1], Patrick Merkel[1], Dong Keun Rhee[1] and Allison C Sylvetsky[1,2,*]

[1]Department of Exercise and Nutrition Sciences, Milken Institute School of Public Health, The George Washington University, Washington DC 20052, USA: [2]Sumner M. Redstone Global Center for Prevention and Wellness, Milken Institute School of Public Health, The George Washington University, Washington DC 20052, USA

Submitted 9 October 2019: Final revision received 10 March 2020: Accepted 20 March 2020: First published online 24 June 2020

Abstract

Objective: To compare the sugar content of items at four multinational fast-food chains, across three countries.

Design: Total sugar (g)/per serving was extracted from online nutrition information, and sugar/100 g serving was calculated. Foods were categorised as: breakfast sandwiches, burgers, sandwiches, desserts and condiments. Beverages were categorised as fountain, frozen or pre-packaged. Sugar (g) was compared across countries using linear mixed-effects models. Pairwise comparisons were performed with Tukey–Kramer adjustments.

Setting: USA, Germany and Australia.

Participants: Burger King™ (Hungry Jack's™), Kentucky Fried Chicken™, McDonald's™ and Subway™.

Results: Differences in total sugar/100 g or ml were observed across countries for burgers (*n* 104), desserts (*n* 110), sandwiches (*n* 178), pre-packaged beverages (*n* 36) and frozen beverages (*n* 72). Comparing identical items across countries (e.g. BigMac™ from McDonalds in USA, Germany and Australia), burgers (*n* 10 available in all three countries) had lower sugar content in Australia (3·4 g/100 g) compared with the USA (4·7 g/100 g, $P = 0{\cdot}02$) or Germany (4·6 g/100 g, $P = 0{\cdot}04$), yet no differences were observed in other food categories. Comparing the same beverages across countries (e.g. chocolate shake from Burger King), frozen beverages (*n* 4 available in all three countries) had lower sugar content in Australia (14·2 g/100 ml), compared with the USA (20·3 g/100 ml, $P = 0{\cdot}0005$) or Germany (17·8 g/100 ml, $P = 0{\cdot}0148$), yet no differences were observed in other beverage categories.

Conclusions: Heterogeneity in fast-food sugar content across countries suggests that reductions are possible and should be implemented to reduce health risks associated with excess added sugar intake.

Keywords
Fast food
Added sugar
Obesity
Menu
Restaurant
Soft drinks
Beverages

Consumption of added sugars accounts for approximately 13 % of total daily energy intake in the USA[1]. Associations between added sugar intake, obesity[2], type 2 diabetes[3] and CVD[4] are well-established, and reducing added sugar consumption is a key aspect of public health efforts to prevent obesity and related cardiometabolic diseases[5]. While sugar-sweetened beverages are the leading sources of added sugar in the USA, added sugars are increasingly present in variety of products, particularly ultra-processed (e.g. soft drinks, chips, chocolate, candy, sweetened breakfast cereals, packaged soups, etc.) and convenience foods (e.g. restaurant meals and ready-to-eat foods from grocery stores)[6].

Consumption of fast food, defined as 'convenience food purchased in self-service or carry-out eating places', has increased globally[7,8] and has paralleled rising obesity

*Corresponding author: Email asylvets@gwu.edu

rates[9]. Eating at fast-food restaurants is associated with higher energy and added sugar intake, as well as poorer diet quality[10,11]. Frequent fast-food consumption is also independently associated with the development of obesity and type 2 diabetes in high-income countries, even after controlling for relevant covariates[12]. Associations between fast-food intake, poor diet and adverse health outcomes are most pronounced in socioeconomically disadvantaged neighbourhoods, particularly those with food environments classified as 'food swamps'[13]. 'Food swamps' are regions with a high density of fast-food and junk food options, relative to healthier alternatives, and their presence strongly predicts obesity rates[13].

Several factors inherent to fast food, including excessive portion sizes, palatability, and high solid fat and added sugar content, may contribute to associations between fast-food consumption, obesity and other unfavourable health outcomes[14]. Lowering fast-food consumption is therefore a key component of public health efforts to combat obesity, yet living in an area with a high density of fast-food outlets challenges the effectiveness of weight management programmes[15,16]. Reducing fast-food intake is particularly difficult as it is widely pervasive and highly palatable[17]. In addition, systemic drivers such as economic systems, and environmental drivers such as marketing environments, further promote consumption of fast food, as well as other energy-dense products[18]. It is therefore critical to improve the nutritional composition of menu offerings at these restaurants. Many fast-food chains (e.g. McDonalds™, Burger King™, etc.) are multi-national corporations, and as such, fast-food consumption has been implicated as one of the several causes of the global pandemic of obesity. Fast-food consumption is positively correlated with obesity rates across countries[19,20], yet few studies have compared the energy[21] and nutrient[22] content of fast-food offerings across countries. Roberts *et al.*[21] selected 223 meals from 111 randomly selected restaurants in Brazil, China, Finland, Ghana and India and reported that high energy content in fast-food and full-service restaurant meals was widespread globally, with only meals in China having significantly lower energy content compared with those in the USA. Dunford *et al.*[22] examined salt levels in menu items in several multinational fast-food chains across countries and observed differences in salt content across similar products in different countries. However, no study to date has specifically evaluated the sugar content of fast-food menu items across different countries.

The purpose of this study was to compare the sugar content of menu offerings at four multinational fast-food chains (McDonalds™, Burger King™ (Hungry Jacks™ in Australia), Subway™ and Kentucky Fried Chicken™), across the USA, Germany and Australia. This is important because observed variability in sugar content across very similar products demonstrates that excess sugar is present for non-technical (e.g. food texture and colouring) reasons and suggests that fast-food companies could thus reformulate their offerings to contain less sugar.

Methods

Three high-income, Westernised countries, with relatively similar dietary patterns and publicly available online nutrition information on serving size and total sugar content per serving of menu items at McDonalds™, Burger King™ (Hungry Jacks™ in Australia), Subway™ and Kentucky Fried Chicken™, were selected. Similar to a prior study comparing salt levels in fast food across countries[22], these four multinational chains (McDonalds™, Burger King™ (Hungry Jacks™ in Australia), Subway™ and Kentucky Fried Chicken™) were chosen due to their global presence and the availability of online nutrition data for the vast majority of their offerings. Individual food items on each menu were divided into breakfast sandwiches, burgers, sandwiches, desserts and condiments, as per their classification on their respective online menus. Beverages (excluding hot drinks, such as coffee) were categorised as fountain, frozen (e.g. smoothies) or pre-packaged (e.g. juice box and bottled juice) drinks.

Serving size and total sugar content per serving were extracted for each menu item from the respective chain's website, and unless already provided on the website, total sugar (g) per 100 g or per 100 ml of each item was calculated to standardise comparisons between products. Data extraction for all food items took place between June 2018 and January 2019. Data extraction for beverages was completed in January 2020. The mean sugar content per 100 g (or per 100 ml for beverages) and SD were calculated for each category, overall and separately for each country and restaurant chain. Total sugar per 100 g or 100 ml was analysed, rather than added sugar or free sugar, because amounts of added/free sugars were not available in online nutritional data. A correction factor of 0·75 was applied to the sugar content of fountain drinks from the Burger King™ in the USA and Hungry Jacks™ (Australia) because fountain beverage sugar content at these two chains were provided without accounting for ice (and thus had more sugar per serving or per ml), whereas all of the other chains provided nutritional information only when the beverage included ice. This correction factor was derived using the nutritional information from similar fast-food restaurants (e.g. Arby's™ and In-N-Out™), which provided online nutritional information for fountain beverages both with and without ice.

For food items, linear mixed effects models were used to compare sugar content across countries, both overall, within-menu categories adjusting for clustering within restaurant chains, and within restaurants adjusting for menu categories. Additional linear mixed effects models, adjusted for clustering within categories, were also used to compare

https://doi.org/10.1017/S136898002000110X Published online by Cambridge University Press

sugar content across restaurant chains. For beverages, those with zero sugar content (e.g. diet drinks and water) were excluded from the main analyses and χ^2 tests were performed to compare the percentages of zero-sugar beverages on the menus across countries and restaurants. Since sugar content for beverages was similar between countries and restaurants, linear regression models were performed to compare sugar content across countries overall, within-categories and within-restaurant chains without adjusting for clustering. For models with non-normally distributed residuals, sugar content per 100 g or ml was log-transformed and the models were refitted for improved goodness-of-fit. Pairwise comparisons were performed with Tukey–Kramer adjustments for multiple testing. *P*-values of <0·05 were considered statistically significant for all analyses. All analyses were performed using SAS, version 9.4 (SAS Institute, Inc.).

Results

Online nutritional information was extracted for a total of 545 food items and 211 beverages (169 sugar-containing beverages and forty-two zero-sugar beverages), across the three countries. Each item was available at a minimum of one of the four chains and in at least one country, except for Subway where no information on beverages was available in any of the countries. As shown in Table 1, the number of menu items per category ranged from thirty-six (pre-packaged beverages) to 178 (sandwiches) and varied by country.

When serving size was standardised (assessed per standard 100 g or ml serving), marked variability was observed across categories, with desserts having the highest sugar content (27·2 g/100 g) and sandwiches having the lowest (3·0 g/100 g). For food items, no differences in mean sugar content were observed across countries or restaurants overall. However, differences in mean sugar content were observed between countries in three of five categories (Table 2): burgers (*n* 104), desserts (*n* 110) and sandwiches (*n* 178). No country had consistently higher or lower values across all food categories. For example, burgers had lower sugar content in Australia (3·1 g/100 g) compared with the USA or Germany (4·3 g/100 g and 4·2 g/100 g, respectively, $P < 0·0001$). In contrast, desserts had more sugar in the USA (32·7 g/100 g) than in Australia (24·3 g/100 g, $P = 0·0002$) or Germany (23·6 g/100 g, $P = 0·0005$) and sandwiches in Germany had higher sugar content (3·7 g/100 g) compared with those in the USA (2·8 g/100 g, $P = 0·0194$) or Australia (2·7 g/100 g, $P = 0·0016$). Comparing sugar content across countries in each restaurant chain, McDonald's had significantly higher sugar content in the USA (12·0 g/100 g) than in Australia (9·7 g/100 g, $P = 0·003$), although differences between USA and Germany were not statistically significant (Table 3).

Twenty-two food items were available across all three countries, of which ten were burgers (e.g. BigMac™ and Whopper™), five were sandwiches (e.g. Zinger Sandwich™ and Filet-O-Fish™), three were breakfast sandwiches (e.g. Sausage McMuffin with Egg™ and Bacon, Egg & Cheese™), three were condiments (e.g. ketchup and barbeque sauce) and one was a dessert (e.g. Oreo McFlurry™). Comparison of sugar content of identical food items is shown across countries, by food category, in Table 4. Burgers (*n* 10) had lower sugar content in Australia (3·4 g/100 g) compared to those in the USA (4·7 g/100 g, $P = 0·0187$) or Germany (4·6 g/100 g, $P = 0·0412$), while no differences were observed in other categories. Comparing sugar content in identical food items between countries by restaurant chain (Table 5), menu items at Burger King™ in Australia had lower sugar content (3·1 g/100 g) compared with those in the USA (4·7 g/100 g, $P = 0·0273$), although differences between Australia and Germany were not statistically significant (data not shown). No differences were observed across countries at the other fast-food chains.

For sugar-containing beverages, no differences in mean sugar content were observed across countries or restaurants overall. However, no country consistently had higher sugar content per 100 ml across all beverage categories (Table 2). Pre-packaged drinks from Australia (10·6 g/100 ml) had greater sugar content than those from the USA (7·5 g/100 ml, $P = 0·0233$) or Germany (7·5 g/100 ml, $P = 0·0099$). Conversely, frozen drinks in Australia (10·4 g/100 ml) had lower sugar content per 100 ml serving than those in the USA (17·6 g/100 ml, $P < 0·0001$) or Germany (18·0 g/100 ml, $P < 0·0001$). Comparing sugar content between countries by restaurant chain, Kentucky Fried Chicken™ had significantly lower sugar content in Germany (8·2 g/100 ml) than in Australia (11·5 g/100 ml, $P = 0·0417$), but not in the USA (Table 3). No differences in percentages of zero-sugar beverages were observed across countries or restaurant chains (data not shown).

Fourteen sugar-containing beverages were available across all three countries, of which eight were fountain

Table 1 Count of products across the four fast-food chains for each country by menu category

	USA	Germany	Australia	Total
Menu category				
Breakfast sandwiches	27	24	20	71
Burgers	30	35	39	104
Sandwiches	70	45	63	178
Desserts	41	35	34	110
Condiments	27	25	30	82
Total foods	195	164	186	545
Sugar-containing beverages				
Fountain	34	15	12	61
Pre-packaged	10	16	10	36
Frozen	15	12	45	72
Zero-sugar beverages	17	13	12	42
Total beverages	76	56	79	211
Total foods and beverages	271	220	265	756

https://doi.org/10.1017/S136898002000110X Published online by Cambridge University Press

Table 2 Sugar content* (g/100 g or ml serving) of all fast-food products by menu category, overall and by country

	Overall (*n* 545)		USA (*n* 195)		Germany (*n* 164)		Australia (*n* 186)	
Menu category	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Food items								
Breakfast Sandwiches (*n* 71)	3·1	3·0	3·0	2·3	3·8	4·5	2·5	0·9
Burgers (*n* 104)	3·8	1·1	4·3	1·1	4·2	1·2	3·1†	0·8
Sandwiches (*n* 178)	3·0	1·5	2·8	1·6	3·7‡	1·4	2·7	1·2
Desserts (*n* 110)	27·2	9·1	32·7§	7·9	23·6	6·6	24·3	9·8
Condiments (*n* 82)	20·4	14·6	21·1	16·2	21·1	12·0	19·1	15·4
Overall (*n* 545)	10·7	12·5	11·9	14·2	10·7	10·8	9·4	11·8
	Overall (*n* 169)		USA (*n* 59)		Germany (*n* 43)		Australia (*n* 67)	
Beverage items								
Fountain (*n* 61)	9·0	2·4	9·4	2·5	9·0	2·5	7·8	1·4
Pre-packaged (*n* 36)	8·3	2·8	7·5	2·8	7·5	2·5	10·6‖	2·0
Frozen (*n* 72)	13·2	4·9	17·6	5·2	18·0	2·6	10·4¶	2·8
Overall (*n* 169)	10·6	4·3	11·2	5·1	10·9	5·1	10·0	2·6

*All data are presented as mean and standard deviations.
†Significantly different compared with the USA ($P < 0·0001$) and Germany ($P < 0·0001$).
‡Significantly different compared with the USA ($P = 0·0194$) and Australia ($P = 0·0016$).
§Significantly different compared with Germany ($P = 0·0005$) and Australia ($P = 0·0002$).
‖Significantly different compared with Germany ($P = 0·0099$) and USA ($P = 0·0233$).
¶Significantly different compared with Germany ($P < 0·0001$) and USA ($P < 0·0001$).

Table 3 Sugar content* (g/100 g or ml serving) of all fast-food products by fast-food chain, overall and by country

	Overall (*n* 545)		USA (*n* 195)		Germany (*n* 164)		Australia (*n* 186)	
Fast-food chain	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Food items								
McDonald's (*n* 169)	10·5	11·7	12·0†	12·2	10·3	10·9	9·7	12·4
Burger King (*n* 180)	10·6	11·8	11·4	13·5	12·6	10·2	8·6	11·0
Subway (*n* 127)	9·1	13·0	9·1	14·0	3·5	1·2	11·6	13·8
KFC (*n* 69)	14·0	14·6	18·5	17·0	13·8	13·4	5·4	4·4
	Overall (*n* 169)		USA (*n* 59)		Germany (*n* 43)		Australia (*n* 67)	
Beverage items								
McDonalds's (*n* 70)	10·5	4·5	10·6	5·1	11·8	6·0	9·6	2·6
Burger King (*n* 61)	11·2	4·8	13·0	6·4	10·7	4·2	9·9	3·0
KFC (*n* 38)	10·0	2·7	9·8	2·9	8·2‡	2·6	11·5	1·4

KFC, Kentucky Fried Chicken™.
*All data are presented as mean and standard deviations.
†Significantly different compared with Australia ($P = 0·0030$).
‡Significantly different compared with Australia ($P = 0·0417$).

drinks (e.g. Coke™ and Fanta™), four were frozen beverages (e.g. chocolate shake and Oreo™ shake) and two were pre-packaged beverages (e.g. apple juice and orange juice). Comparing sugar content between countries by category (Table 4), frozen beverages (*n* 4) had significantly lower sugar content in Australia (14·2 g/100 ml) than in the USA (20·3 g/100 ml, $P = 0·0005$) or Germany (17·8 g/100 ml, $P = 0·0148$). No differences in sugar content were observed between countries in each restaurant chain (Table 5).

Discussion

Our findings demonstrate that sugar in identical or similar fast-food menu items is highly variable across countries. Consistent with prior findings for sodium[22], these results indicate that reformulation of fast-food items to contain less added sugar is indeed possible.

Lowering sugar in foods and beverages is particularly challenging because of consumer preferences for products higher in sugar[23]. Furthermore, use of refined sugars is a

https://doi.org/10.1017/S136898002000110X Published online by Cambridge University Press

Table 4 Sugar content* (g/100 g or ml serving) of fast-food menu products available in three countries by menu category, overall and by country

	Overall		USA		Germany		Australia	
Menu category	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Food items								
Breakfast Sandwiches (*n* 3)	2·1	0·7	2·5	0·6	2·1	1·0	1·9	0·5
Burgers (*n* 10)	4·2	1·1	4·7	1·2	4·6	1·0	3·4†	0·8
Sandwiches (*n* 5)	2·8	0·7	2·9	0·8	2·9	0·5	2·7	0·8
Desserts (*n* 1)	23·5	2·1	22·5‡	NA	26·0‡	NA	22·1‡	NA
Condiments (*n* 3)	29·5	7·6	29·3	8·2	28·0	8·1	31·1	9·6
Overall (*n* 22)	7·9	10·0	8·2	9·9	8·0	9·8	7·7	10·8
Beverage items								
Fountain (*n* 8)	9·1	1·2	9·1	1·2	9·6	1·1	8·6	1·4
Pre-packaged (*n* 2)	7·8	2·7	7·3	4·0	7·4	2·3	8·7	3·6
Frozen (*n* 4)	17·4	2·9	20·3	1·1	17·8	1·7	14·2§	1·5
Overall (*n* 14)	11·3	4·4	12·0	5·6	11·6	4·3	10·2	3·1

*All data are presented as mean and standard deviations.
†Significantly different compared with the USA ($P = 0·0187$) and Germany ($P = 0·0412$).
‡NA indicates no SD, as only one dessert was commonly available across all three countries.
§Significantly different compared with Germany ($P = 0·0148$) and USA ($P = 0·0005$).

Table 5 Sugar content* (g/100 g or ml serving) of fast-food menu products available in three countries by fast-food chain, overall and by country

	Overall		USA		Germany		Australia	
Fast-food chain	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Food items†								
McDonald's (*n* 13)	11·0	12·1	11·2	12·0	10·9	12·1	10·9	13·3
Burger King (*n* 5)	4·1	1·1	4·7‡	1·2	4·5	0·7	3·1	0·5
Subway (*n* 3)	2·9	0·3	3·0	0·3	3·0	0·1	2·6	0·2
Beverage items†								
McDonalds's (*n* 6)	10·0	4·0	9·8	5·6	10·1	3·8	10·1	3·0
Burger King (*n* 7)	12·4	4·8	14·0	5·7	13·1	4·8	10·2	3·6

*All data are presented as mean and standard deviations.
†Kentucky Fried Chicken™ was excluded from the analysis, as only one food product was commonly available across three countries.
‡Significantly different compared with Australia ($P = 0·0273$).

cost-effective (<$0·10/lb) approach to maintain or improve product palatability[24]. Sugar is also, in some instances, added to foods and beverages for non-taste-related reasons, such as texture and browning[25]. However, our results clearly demonstrate that further reductions in sugar content of fast food are feasible.

Given adverse health outcomes associated with excess added sugar intake[26–30] and the established contribution of fast food to obesity[12,13,31–33], menu items should be reformulated to achieve sugar content consistent with (or ideally, less than) the lower end of the observed range in our analysis. To date, however, product reformulation efforts by fast-food companies have been largely voluntary[34] and most have focused on beverages. For example, Wendy's™ and Burger King™ removed soda and soft drinks from the kids' menus[35,36] and McDonald's™[34] switched to a lower-sugar, organic apple juice. Although well-intended, these efforts have had limited effectiveness in reducing availability of sugary beverages, as replacements for sodas removed from children's menus include other beverages high in free sugars including flavoured milks and 100 % fruit juice[37]. Another commonly used approach for lowering sugar content is replacement of added sugars with low-energy sweeteners, yet the extent to which low-energy sweeteners are helpful for encouraging weight management and preventing cardiometabolic disease is controversial[38]. Nonetheless, consumption of foods and beverages containing low-energy sweeteners has increased markedly in the USA[39] and worldwide[40] in recent decades, and this trend will likely continue with further emphasis on reducing added sugar content[5], including in fast-food items.

In addition to modifying offerings on children's menus, fast-food companies have also made progress in promoting healthier food options through changes in advertising[41]. For example, from 2009 to 2012, the number of TV ads

https://doi.org/10.1017/S136898002000110X Published online by Cambridge University Press

viewed by teens was unchanged, yet fast-food companies advertised lower energy items[41]. This resulted in a 16 % decline in the average energy per ad viewed, and the percentage of energy from sugar and saturated fat per ad viewed was also reduced[41]. While these actions are indeed commendable, further efforts are needed, particularly with respect to non-beverage menu offerings. These efforts would be well-aligned with recent obesity prevention-related nutrition policies worldwide (including all three countries in our analysis), which collectively aim to modify the 'obesogenic' environment in order to encourage a healthier lifestyle[42].

A key limitation of this analysis was the lack of complete nutrition data for menu offerings at restaurants located outside of North America, Europe and Australia, precluding inclusion of countries on other continents. Another limitation was that not all menu items were available across the three countries included, which necessitated comparison across broader product categories, in addition to a limited number of individual products. We also limited the present analysis to menu items specifically at fast-food chains and did not evaluate menu items at full-service restaurants, which are also high in sugar, saturated fat and energy[21]. Finally, publicly available nutrition information was relied upon in this analysis, and while restaurant nutritional information is thought to be accurate overall, substantial inaccuracy has been reported for some individual items[43], and thus, product sugar content in this analysis may be subject to error.

Despite these limitations, our analysis captured a wide range of food and beverage menu offerings at four multinational fast-food chains across three countries and the results provide novel insight into the feasibility of reducing added sugar in fast food. These data also serve as the foundation for future comparison of the sugar content in fast-food menu items over time and provide a baseline to assess the magnitude of these potential changes. Future assessment of additional fast-food as well as full-service restaurant chains and inclusion of additional countries is needed to enhance generalisability of the study findings and identify further opportunities for reducing added sugar in fast food.

Acknowledgements

Acknowledgements: None. *Financial support:* None. *Conflict of interest:* The authors have no conflicts of interest to report. *Authorship:* N.L. and A.C.S. designed the study. N.L. and D.R. extracted the data. N.L. wrote the first draft of the manuscript, with assistance from P.M., Q.H., D.R. and A.C.S., Q.H. and D.R. analysed the data. All authors have edited and reviewed the manuscript and approved the final version submitted to Public Health Nutrition. *Ethics of human subject participation:* Not applicable.

References

1. Bowman SA, Clemens JC, Martin CL *et al.* (2017) *Added Sugars Intake of Americans: What We Eat in America, NHANES 2013–2014*. Food Surveys Research Group Dietary Data Brief. Beltsville, MD: Beltsville Human Nutrition Research Center, Agricultural Research Service, U.S. Department of Agriculture.
2. Malik VS, Pan A, Willett WC *et al.* (2013) Sugar-sweetened beverages and weight gain in children and adults: a systematic review and meta-analysis. *Am J Clin Nutr* **98**, 1084–1102.
3. Palmer JR, Boggs DA, Krishnan S *et al.* (2008) Sugar-sweetened beverages and incidence of type 2 diabetes mellitus in African American women. *Arch Intern Med* **168**, 1487–1492.
4. Malik VS, Popkin BM, Bray GA *et al.* (2010) Sugar-sweetened beverages, obesity, type 2 diabetes mellitus, and cardiovascular disease risk. *Circulation* **121**, 1356–1364.
5. Welsh JA, Lundeen EA & Stein AD (2013) The sugar-sweetened beverage wars: public health and the role of the beverage industry. *Curr Opin Endocrinol Diabetes Obes* **20**, 401–406.
6. Popkin BM & Hawkes C (2016) Sweetening of the global diet, particularly beverages: patterns, trends, and policy responses. *Lancet Diabetes Endocrinol* **4**, 174–186.
7. Xue H, Wu Y, Wang X *et al.* (2016) Time trends in fast food consumption and its association with obesity among children in China. *PLoS One* **11**, e0151141.
8. Gupta P, Shah D, Kumar P *et al.* (2019) Indian academy of pediatrics guidelines on the fast and junk foods, sugar sweetened beverages, and energy drinks. *Indian Pediatr* **56**, 849–863.
9. Rosenheck R (2008) Fast food consumption and increased caloric intake: a systematic review of a trajectory towards weight gain and obesity risk. *Obes Rev* **9**, 535–547.
10. Bowman SA, Gortmaker SL, Ebbeling CB *et al.* (2004) Effects of fast-food consumption on energy intake and diet quality among children in a national household survey. *Pediatrics* **113**, 112–118.
11. Bowman SA & Vinyard BT (2004) Fast food consumption of U.S. adults: impact on energy and nutrient intakes and overweight status. *J Am Coll Nutr* **23**, 163–168.
12. Pereira MA, Kartashov AI, Ebbeling CB *et al.* (2005) Fast-food habits, weight gain, and insulin resistance (the CARDIA study): 15-year prospective analysis. *Lancet* **365**, 36–42.
13. Cooksey-Stowers K, Schwartz MB & Brownell KD (2017) Food swamps predict obesity rates better than food deserts in the United States. *Int J Environ Res Public Health* **14**, 1366.
14. McCrory MA, Harbaugh AG, Appeadu S *et al.* (2019) Fast-food offerings in the United States in 1986, 1991, and 2016 show large increases in food variety, portion size, dietary energy, and selected micronutrients. *J Acad Nutr Diet* **119**, 923–933.
15. Tarlov E, Wing C, Gordon HS *et al.* (2018) Does effectiveness of weight management programs depend on the food environment? *Health Serv Res* **53**, 4268–4290.
16. Feathers A, Aycinena AC, Lovasi GS *et al.* (2015) Food environments are relevant to recruitment and adherence in dietary modification trials. *Nutr Res* **35**, 480–488.
17. Min J, Jahns L, Xue H *et al.* (2018) Americans' perceptions about fast food and how they associate with its consumption and obesity risk. *Adv Nutr* **9**, 590–601.
18. Swinburn BA, Sacks G, Hall KD *et al.* (2011) The global obesity pandemic: shaped by global drivers and local environments. *Lancet* **378**, 804–814.
19. De Vogli R, Kouvonen A & Gimeno D (2014) The influence of market deregulation on fast food consumption and body mass index: a cross-national time series analysis. *Bull World Health Organ* **92**, 99–107, 107A.

20. Braithwaite I, Stewart AW, Hancox RJ *et al.* (2014) Fast-food consumption and body mass index in children and adolescents: an international cross-sectional study. *BMJ Open* **4**, e005813.
21. Roberts SB, Das SK, Suen VMM *et al.* (2018) Measured energy content of frequently purchased restaurant meals: multi-country cross sectional study. *BMJ* **363**, k4864.
22. Dunford E, Webster J, Woodward M *et al.* (2012) The variability of reported salt levels in fast foods across six countries: opportunities for salt reduction. *CMAJ* **184**, 1023–1028.
23. Markey O, Lovegrove JA & Methven L (2015) Sensory profiles and consumer acceptability of a range of sugar-reduced products on the UK market. *Food Res Int* **72**, 133–139.
24. Drewnowski A (2003) Fat and sugar: an economic analysis. *J Nutr* **133**, 838S–840S.
25. Goldfein KR & Slavin JL (2015) Why sugar is added to food: food science 101. *Compr Rev Food Sci Food Saf* **14**, 644–656.
26. Hu FB (2013) Resolved: there is sufficient scientific evidence that decreasing sugar-sweetened beverage consumption will reduce the prevalence of obesity and obesity-related diseases. *Obes Rev* **14**, 606–619.
27. Malik VS & Hu FB (2015) Fructose and cardiometabolic health: what the evidence from sugar-sweetened beverages tells us. *J Am Coll Cardiol* **66**, 1615–1624.
28. Welsh JA & Cunningham SA (2011) The role of added sugars in pediatric obesity. *Pediatr Clin North Am* **58**, 1455–1466, xi.
29. Welsh JA, Sharma A, Abramson JL *et al.* (2010) Caloric sweetener consumption and dyslipidemia among US adults. *JAMA* **303**, 1490–1497.
30. Welsh JA, Sharma A, Cunningham SA *et al.* (2011) Consumption of added sugars and indicators of cardiovascular disease risk among US adolescents. *Circulation* **123**, 249–257.
31. Davis B & Carpenter C (2009) Proximity of fast-food restaurants to schools and adolescent obesity. *Am J Public Health* **99**, 505–510.
32. Duffey KJ, Gordon-Larsen P, Jacobs DR Jr *et al.* (2007) Differential associations of fast food and restaurant food consumption with 3-y change in body mass index: the coronary artery risk development in young adults study. *Am J Clin Nutr* **85**, 201–208.
33. Poti JM, Duffey KJ & Popkin BM (2014) The association of fast food consumption with poor dietary outcomes and obesity among children: is it the fast food or the remainder of the diet? *Am J Clin Nutr* **99**, 162–171.
34. Aubrey A (2018) McDonald's Commits To More Balanced Happy Meals By 2022. https://www.npr.org/sections/thesalt/2018/02/15/585881037/mcdonald-s-commits-to-more-balanced-happy-meals-by-2022 (accessed August 2019).
35. Toy S (2017) Fast-food restaurants pledged to offer healthier options for kids. How have they done? *USA Today*.
36. Interest CfSitP (2015) Burger King Pulls Soda from Kids' Menu. https://cspinet.org/new/201503101.html (accessed January 2020).
37. Moran AJ, Block JP, Goshev SG *et al.* (2017) Trends in nutrient content of children's menu items in U.S. chain Restaurants. *Am J Prev Med* **52**, 284–291.
38. Sylvetsky AC & Rother KI (2018) Nonnutritive sweeteners in weight management and chronic disease: a review. *Obesity (Silver Spring)* **26**, 635–640.
39. Sylvetsky AC, Jin Y, Clark EJ *et al.* (2017) Consumption of low-calorie sweeteners among children and adults in the United States. *J Acad Nutr Diet* **117**, 441–448.e442.
40. Sylvetsky AC & Rother KI (2016) Trends in the consumption of low-calorie sweeteners. *Physiol Behav* **164**, 446–450.
41. Yale Rudd Center for Food Policy and Obesity (2013) *Measuring Progress in Nutrition and Marketing to Children and Teens*. http://www.fastfoodmarketing.org/media/FastFoodFACTS_Report.pdf (accessed July 2019).
42. Zhang Q, Liu S, Liu R *et al.* (2014) Food policy approaches to obesity prevention: an international perspective. *Curr Obes Rep* **3**, 171–182.
43. Urban LE, McCrory MA, Dallal GE *et al.* (2011) Accuracy of stated energy contents of restaurant foods. *JAMA* **306**, 287–293.

https://doi.org/10.1017/S136898002000110X Published online by Cambridge University Press