CURRENT DEVELOPMENTS IN NUTRITION

Variations in Sugar Content of Flavored Milks and Yogurts: A Cross-Sectional Study across 3 Countries

Daisy H Coyle[1,2] Rhoda Ndanuko[1] Sarinda Singh[1] Polly Huang[1] and Jason H Wu[1,2]

[1]The George Institute for Global Health, Sydney, NSW, Australia and [2]University of New South Wales, Sydney, NSW, Australia

ABSTRACT

Background: The consumption of dairy products is encouraged at all life stages as a nutrient-rich component of the diet. However, many milk and yogurt products, particularly flavored varieties, may contain large amounts of free sugar.

Objectives: The aim of this paper was to evaluate the availability and sugar content of flavored milks and yogurts in supermarkets across 3 countries: Australia, England, and South.

Methods: Nutrition information for flavored milks and yogurts was collected by trained researchers and supplemented by crowd-sourced data from a smartphone application. Data were extracted in April 2018 and 3724 milk and yogurt products were available for analysis. Mean sugar concentrations were compared across countries with the use of ANOVA followed by Tukey's post-hoc pairwise comparisons. Sugar concentrations were compared with the UK's "green" traffic-light classifications.

Results: Approximately 74% ($n = 2753$) of all products were flavored. Flavored products contained nearly twice the average total sugar content of unflavored products, with substantial variability: mean total sugar was 9.1 g/100 mL (range: 4.3–15.0 g/100 mL) and 11.5 g/100 g (range: 0.1–22.6 g/100 g) for flavored milks and yogurts, respectively. Free sugars contributed an estimated 41% and 42% of total sugar in milks and yogurts, respectively. Flavored milks in England had ~0.7 g/100 mL higher total sugar on average compared with Australia and South Africa ($P \leq 0.04$), whereas flavored yogurts in South Africa had the lowest average total sugar (~2 g/100 g lower than England and Australia; $P < 0.001$). Less than 4% of flavored products would receive a "green" rating under the UK traffic-light labeling scheme.

Conclusions: In Australia, England, and South Africa, flavored milks and yogurts are highly prevalent in the food supply and contain significantly higher concentrations of total and added sugars than unflavored products. *Curr Dev Nutr* 2019;3:nzz060.

Keywords: sugar, free sugar, nutrition label, dairy, milk, yogurt, sugar reduction, noncommunicable disease, public health

Manuscript received January 8, 2019. Initial review completed April 17, 2019. Revision accepted April 30, 2019. Published online May 8, 2019.

DHC, RN, PH. and JHW are researchers within a National Health and Medical Research Council Centre for Research Excellence in reducing salt intake through the use of food policy interventions (APP1117300). JHW is supported by a UNSW Scientia Fellowship. DHC is supported by an Australian Government Research Training Program (RTP) Scholarship.

Author disclosures: DHC, RN, SS, PH, and JHW, no conflicts of interest.

Supplemental Tables 1–3 are available from the "Supplementary data" link in the online posting of the article and from the same link in the online table of contents at https://academic.oup.com/cdn/.

Address correspondence to DHC (e-mail: dcoyle@georgeinstitute.org.au).

Introduction

Excess sugar consumption has been associated with a range of unfavorable health outcomes including weight gain (1), dental caries (2, 3), cardiovascular disease (4), and type 2 diabetes (5). In 2015, the WHO published guidelines that recommend adults and children reduce their daily intake of "free sugars"—sugars added to foods by the manufacturer or consumer—to <10% of their total energy intake (6). Moreover, a further reduction to <5% of total energy intake was recommended for additional health benefits (6).

Despite these WHO guidelines, global per-capita consumption of sugar has generally continued to exceed recommendations (7, 8). At the same time, governments across the globe are increasingly interested in policy measures including labeling, portion-size restrictions, taxation, and product reformulation to decrease population-level sugar consumption (9, 10). In Australia, England and South Africa—countries with high and increasing prevalence of non-communicable diseases, including obesity, diabetes, and cardiovascular disease (11–14)—governments have highlighted the growing need to improve diets. The United Kingdom and South Africa have adopted a strong regulatory approach through taxation of sugar-sweetened beverages (15, 16). In the United Kingdom, voluntary reformulation targets for sugar have been introduced across a series of food and beverage categories, and Australia will release a set of similar targets in 2019 (17–19).

Milk and dairy products, including cheese and yogurt, are recommended at all life stages as an important component of a healthy, balanced diet (20–22). Most national-level dietary guidelines worldwide recommend that adults consume ∼3 servings of dairy every day (1 serving equates to ∼250 mL of milk and 150–200 g of yogurt). These guidelines also often encourage selection of low-fat dairy foods based on concerns about saturated fat consumption (20–22). Dairy foods are nutrient rich, providing a diverse range of macro- and micronutrients including protein, calcium, magnesium, zinc, riboflavin, vitamin K, and vitamin B-12 (23, 24). They are also regarded as beneficial for bone health, muscle and nerve function, and cardiometabolic health (23, 25).

In recent years, there has been an increase in the demand and consumption of dairy products worldwide, especially milk and yogurt in developing countries such as China and India (26–28). However, much of the growth in demand for dairy has been due to flavored products (29), which are often sweetened with plain sugar, syrups, honey, and fruit concentrates. Proliferation of flavored dairy products with high concentrations of added sugar may be driven by dietary guidelines and consumer demand for low-fat and fat-free dairy products. In addition, the need for added sugars to increase sweetness and compensate for the loss of palatability and texture due to the removal of fat may also be contributing to the increased availability of these products (30–32).

Given the increasingly important role of dairy foods as critical sources of energy and nutrients globally, and concerns over adverse health effects of excess sugar consumption, the primary aim of this study was to evaluate the availability of unflavored compared with flavored milks and yogurts available in retail stores across multiple countries. The secondary aim was to investigate the amount of total and estimated free sugars in flavored milks and yogurts and to determine whether total sugar concentrations differ according to fat content. To date, only a handful of studies have evaluated sugar concentrations in dairy products and these have been conducted in individual countries (33–35), limiting the ability to make comparisons between countries. Existing studies also had small sample sizes, with low statistical power to assess whether sugar content differed substantially between regular compared with low-fat or fat-free varieties. To address these gaps in evidence, 3 countries were selected for the current analyses: Australia, England, and South Africa. These countries were chosen due to the availability of country-specific datasets, completeness of data, particularly for sugar and fat, and to allow for representation of both middle- and high-income countries that have implemented policies to reduce population sugar consumption.

Methods

Data source

Data on dairy milk and yogurt products were collected from 3 countries, Australia, England, and South Africa, as part of the Global Food Monitoring Group (36). These countries represent middle-income (South Africa) and high-income countries (Australia and England) (17, 18). The country-specific protocols for data collection, entry, and processing, including locations of retail stores, have been described elsewhere for Australia (36), South Africa (37), and England (38). In brief, in each country a priming dataset was set up by the George Institute, Australia, by having trained research assistants visit all major supermarket stores to collect nutrient data from the nutrition information panels (NIPs) of all packaged products (36, 38). Additional data are sourced directly through industry or the FoodSwitch smartphone application in which consumers send in nutritional data when it is not already available in the database (38). For each country, product and nutrition data were extracted in April 2018, including product name, manufacturer, brand, nutrient claims, ingredient lists, and nutrient data per 100 g including sugar (g/100 g) and fat (g/100 g) as reported on the NIP.

Inclusion and exclusion criteria

Products included in the current analyses were ready-to-eat dairy milk and yogurt products made from either cow, goat, buffalo, or sheep milk. Products excluded were condensed and evaporated products, crème fraiche and fromage frais, dairy desserts, probiotic drinks, infant products, powdered products, and water-based coffee products. Due to the multiple NIPs, variety packs with multiple flavors were also excluded. Plant-based milks and yogurts (e.g., made from soy, coconut, almond, and rice) were excluded. Products were only included if they contained nutrition information for both the total sugar and total fat content. Where the same product was available in >1 store within a country or when the same product was available in different pack sizes, only 1 entry was retained. Where the same product was retailed across multiple countries, it was counted each time for each country.

Product categorization

All milk and yogurt products were classified as either "unflavored" or "flavored," based on information given in the product name. Milks or yogurts with a flavoring listed in the product name such as chocolate, vanilla, or honey were classified as flavored, and products without were classified as unflavored. (See **Supplemental Table 1** for a list of unflavored and flavored products included in this analysis.)

"Regular fat" and "low-fat" products were defined according to the Australian Dietary Guidelines cutoffs; "low-fat" products are those with a fat content ≤1.5 g/100 mL for liquids or ≤3 g/100 g for solids (20). Any products with a fat content above these values were classified as "regular" fat.

Classification and quantification of total and free sugars

For the purposes of this paper, total sugar is defined as the total sugar content (g/100 g or g/100 mL) as specified on the NIP. Estimates of free sugars were calculated according to a previously defined imputation approach: subtracting the estimated intrinsic sugar content (i.e., lactose content) from the total content of sugar as reported on the NIP (39).

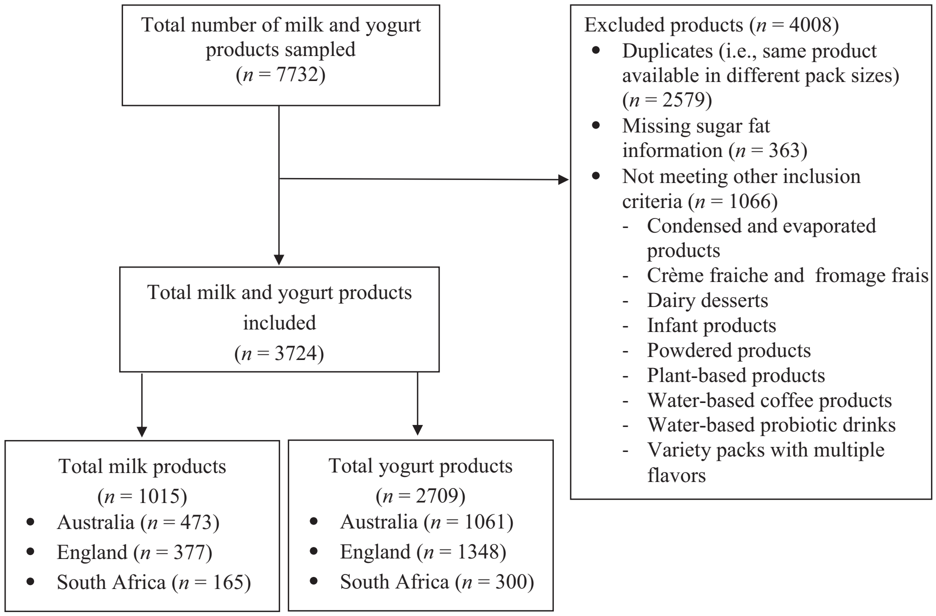

FIGURE 1 Flow chart of data collection and milk and yogurt products available for analyses.

The intrinsic mean sugar content for milk and yogurt was estimated as 5.4 g/100 ml and 6.7 g/100 g, respectively. This was calculated as the mean total sugar content across all unflavored, added sugar free, cow-milk-based milk and yogurt products available in the Australian Food and Nutrient Database (40).

Milk and yogurt products were compared with the UK front-of-pack (FOP) traffic-light labeling system. This labeling system applies to dairy products and was used as a current standard to categorize the sugar content of milk and yogurt products in this study. This labeling system classifies dairy products as low sugar (green traffic light), medium sugar (amber), and high sugar (red) (41). To meet the green traffic-light criteria, yogurt must contain <5 g total sugar/100 g and milk must contain <2.5 g of total sugar/100 mL.

To put into context how free-sugar concentrations of dairy products compare with the WHO guidelines on free-sugar intake, the average amount of free sugar that would be consumed in a "typical serving" of flavored milk and yogurt was calculated as mean free-sugar concentration (g/100 g)/100 × typical serving (g). The typical serving size was calculated by taking the most common serving size listed on the NIP of all products across all countries. Similar calculations were repeated to determine the maximum amount of free sugar consumed in a typical serving. The contribution of free sugar to total energy intakes in a typical serving was calculated and compared against the WHO free-sugar targets of <5% and 10% of total energy from free sugars (~25 g and ~50 g sugar/d, respectively) (6).

Statistical analysis

The number and proportion of unflavored and flavored milk and yogurt products were calculated for each country. Descriptive statistics describing the mean sugar content (g/100 g or g/100 mL) were generated for each country for all product types including unflavored and flavored varieties.

Differences in the proportion of unflavored and flavored products across countries were examined by Pearson's chi-squared tests. To determine differences in the mean sugar content across countries, 1-factor ANOVA tests were conducted with Tukey's honest significance difference test post-hoc analyses.

Independent t tests were used for pairwise comparisons of mean difference in the sugar content for regular fat compared with low-fat milk and yogurts across each of the 3 countries.

Statistical analyses were conducted with Stata 15.0 (Stata Corporation). All tests were 2-sided and a P value of <0·05 was considered statistically significant.

Results

A total of 7732 milk and yogurt products were identified in the FoodSwitch databases across the 3 countries. Of these, 2579 were excluded because they were duplicate products (i.e., same products available in different pack sizes), 1428 were excluded for not meeting other inclusion criteria, and a further 363 were excluded due to missing information about sugar or fat content. This resulted in 3724 products available for analysis, comprising 1015 milks and 2709 yogurts (**Figure 1**).

Proportion of flavored milk and yogurt products

Across all countries, England had the largest number of products (n = 1725, 46%), followed by Australia (n = 1534, 41%), and South Africa (n = 465, 12%).

Across the 3 countries (**Table 1**), a little over 50% of milk products were unflavored varieties with the rest being flavored, with no significant differences between countries in the proportion of unflavored compared with flavored products (P-chi-square = 0.55). In comparison, in each of the countries, the vast majority of the yogurt products were flavored (>4 times as prevalent as unflavored products), with England having the largest proportion of products as flavored yogurts (~87%; P-chi-square < 0.001).

TABLE 1 Proportion of unflavored and flavored milk and yogurt products by country[1]

Product type	Country	Unflavored, *n* (%)	Flavored, *n* (%)	Total
Milk	Australia	247 (52)	226 (48)	473
	England	211 (56)	166 (44)	377
	South Africa	89 (54)	76 (46)	165
	Total	547	468	1015
Yogurt	Australia	203 (19)	858 (81)	1061
	England	173 (13)	1175 (87)	1348
	South Africa	48 (16)	252 (84)	300
	Total	424	2285	2709

[1]Proportions of flavored milks were similar between countries (P-chi-square = 0.55), whereas the proportions differed slightly between countries for flavored yogurts, with England having the highest percentage of flavored products (P-chi-square < 0.001).

Sugar content of flavored milks and yogurts

The total sugar content of flavored milks (n = 468) ranged from 4.3 to 15.0 g/100 mL with a mean ± SD of 9.1 ± 2.0 g/100 mL across all countries, an estimated 41% of which being free sugars (3.7 ± 2.0 g/100 mL). The total sugar content was significantly different between the 3 countries (P < 0.001). Flavored milks in England had slightly higher mean total sugar than products from Australia (mean difference: 0.7 g/100 mL; 95% CI: 0.2, 1.2 g/100 mL; P < 0.001) and South Africa (0.7 g/100 mL; 95% CI: 0.02, 1.3 g/100 mL; P = 0.04) (**Table 2**). Flavored milks had nearly double the total sugar content of unflavored milks (mean ± SD: 4.8 ± 0.6 g/100 mL, Table 2).

Across all countries, the total sugar content for flavored yogurts (n = 2285) ranged from 0.1 to 22.6 g/100 g, with a mean ± SD of 11.5 ± 3.5 g/100 mL, of which 42% was estimated to be free sugar (4.8 ± 3.5 g/100 mL). The sugar content was significantly different between all 3 countries (P < 0.001). Flavored yogurts from South Africa had lower concentrations of total sugar than those from England (mean difference: 2.3 g/100 g; 95% CI: 1.7, 2.9 g/100 g; P < 0.001) and Australia (1.8 g/100 g; 95% CI: 1.2, 2.4 g/100 g; P < 0.001 (Table 2). The total sugar content also differed slightly but significantly between England and Australia, with England on average higher by ∼0.5 g/100 g; 96% CI: 0.1, 0.9 g/100 g (P = 0.005). Similar to milk products, flavored yogurts contained almost double the sugar of unflavored yogurts (mean ± SD: 6.2 ± 3.1 g/100 g).

TABLE 2 Sugar content in unflavored and flavored milks and yogurts in Australia, England, and South Africa

Product type	Country	*n*	Total sugar content per 100 g/mL
Milk			
Unflavored	Australia	247	4.9 ± 0.6
	UK	211	4.8 ± 0.3
	South Africa	89	4.4 ± 0.7
Flavored	Australia	226	8.8 ± 1.7
	UK	166	9.5 ± 2.1
	South Africa	76	8.9 ± 2.4
Yogurt			
Unflavored	Australia	203	6.6 ± 3.3
	UK	173	5.9 ± 2.6
	South Africa	48	5.6 ± 3.5
Flavored	Australia	858	11.9 ± 3.4
	UK	1175	12.4 ± 3.4
	South Africa	252	10.1 ± 3.9

[1]Sugar content values are means ± SDs.

Contribution of free sugar to energy intake and comparison against UK traffic-light criteria

No flavored milks and only 3.7% of flavored yogurts had a total sugar content that was low enough to meet the "green" traffic-light criteria in UK FOP labeling (**Table 3**). The most common serving sizes reported on nutrition information panels across countries were 250 mL for milk and 150 g for yogurts. Table 3 shows the estimated mean free sugar that would be consumed in a typical serving of flavored milks and yogurts. A typical serving of milk would result in on average 9.3 g of free sugar, equivalent to close to 2% of total energy intake and nearly half of the 5% WHO target (25 g/d). A typical serving of flavored yogurt would contribute on average 7.2 g of free sugar, equivalent to just over 1% of energy intakes. On the other hand, consumption of milks and yogurts with the highest free-sugar content would result in intakes of ∼24 g of free sugar per typical serving. This contributes to 4.4% of total energy intake, equivalent to nearly half of the 10% WHO target (50 g/d) and close to 90% of the 5% WHO target (25 g/d).

Sugar content of regular and low-fat flavored milks and yogurts

Among the 468 flavored milk products included in these analysis, 201 (43%) were classified as low-fat varieties. On the other hand, 1285 (56%) of the flavored yogurts were classified as low-fat products.

Across all countries, low-fat flavored milk and yogurt products generally had similar, or moderately lower average total sugar contents compared with regular-fat products. For example, in England, low-fat flavored yogurts had lower average total sugar than regular-fat flavored yogurt (mean difference: −2.4 g/100 g; 95% CI: −2.8, −2.1 g/100 g). (**Supplemental Table 2**). For unflavored milks and yogurts, average sugar content was also generally similar when comparing low-fat and regular-fat varieties (**Supplemental Table 3**).

Discussion

The present study of nearly 3000 flavored milks and yogurts available for sale in 3 countries provides a comprehensive evaluation of their availability across these countries, as well as the average and variation in the sugar content of these products. There was a high prevalence of flavored products in the food supply across all countries, especially for yogurts. The total sugar content of flavored milks and yogurts was nearly double that of unflavored products, and the vast majority of such products would not receive a "green" rating under the existing UK labeling scheme. Free sugar accounted for about half of total sugars in flavored milks and yogurts, and a typical serving of flavored milk and yogurt could account for a substantial portion of the daily WHO free-sugar limit.

Although dairy products are nutrient-rich foods, the free-sugar content in flavored varieties is disconcerting with a typical serving size of the highest-sugar products contributing up to 4.4% of total energy intake per day, nearly meeting the 5% WHO sugar target. As most

TABLE 3 Amount of flavored milks ($n = 468$) and yogurts ($n = 2285$) meeting the UK "green" traffic-light criteria and contribution of free sugar in a typical serving[1]

Product type	Meeting "green" traffic light for sugar, n (%)	Mean free sugar, g/100 mL or g/100 g	Typical serving size[2]	Mean free-sugar content, g[3]	Contribution of free sugar to energy intakes, %[4]
Flavored milk	0 (0)				
Mean sugar content		3.7	250 mL	9.3	1.7
Highest sugar content		9.6	250 mL	24.0	4.4
Flavored yogurt	84 (3.7)				
Mean sugar content		4.8	150 g	7.2	1.3
Highest sugar content		15.9	150 g	23.9	4.4

[1]For a product to meet the UK "green" traffic-light criteria for sugar, it must contain <5 g sugar/100 g and <2.5 g sugar/100 mL liquid.
[2]The typical serving size is the most frequent serving size reported on packs across all countries.
[3]The free-sugar content was calculated by subtracting the total sugar content by the estimated intrinsic sugar content (5.4 g/100 g for milk and 6.7 g/100 g for yogurt.
[4]Contribution of free-sugar content to diet was based on an average energy intake of 8700 kJ/d; 1 g sugar equates to 16 kJ of energy.

dietary guidelines recommend 2–3 servings of dairy each day (20–22), our findings highlight the possibility that those who frequently consume flavored milks and yogurts could be at increased risk of exceeding their recommended daily intake of sugar. Such risks are potentially exacerbated by the high prevalence of flavored products as identified by our study, as product availability is a strong determinant of consumer choices (42, 43). Dietary guidelines may need to incorporate recommendations to choose unflavored milks and yogurts over flavored varieties, particularly for those who are concerned about controlling their sugar intake. Other factors may also influence consumer choice, such as presence of nutrition and health claims (e.g., "low-fat" claims) (44) and nutrition labeling such as the Health Star Rating (45–47).

Our results also have implications for public health nutrition initiatives. Sugar reduction strategies are now on the policy agenda in many countries (17–19). A number of studies suggest such government reformulation initiatives can positively influence sugar intakes, resulting in improved health outcomes. A recent meta-analysis of sugar reformulation initiatives found that consumption of reformulated foods and beverages can result in an 11% reduction in total sugar intakes, corresponding to a 91-g reduction per person per day (48). Various studies have also reported positive effects of sugar reformulation on caloric intake (49, 50), body weight (48, 51), and prevalence of obesity (50, 52, 53).

The high average amounts of total and free sugars observed in flavored milk and yogurts in our study support the need to set reformulation targets for these products to reduce the amount of free sugars added. Furthermore, our study identified a wide variability in sugar content within product categories, which is likely explained by varying amounts of added free sugar. The variability in sugar content was particularly evident for flavored yogurts, which ranged from 0.1 to 22.6 g/100 g. The low end of this sugar range (0.1 g/100 g) can be attributed to a very small number ($n = 6$) of flavored yogurts from South Africa, marketed as "diabetes friendly" and sweetened with artificial sweeteners rather than free sugar. The range in sugar concentrations observed for flavored products suggests that reformulation is likely feasible from both a food technology and consumer acceptability perspective.

Growing evidence suggests that the effects of dairy products on cardiovascular and metabolic health appear to differ more by type (i.e., milk, yogurt, cheese, butter, etc.) rather than by their fat content (24, 54). Nevertheless, the standard dietary recommendation to consume low-fat dairy products has led to a proliferation of such products, which account for >50% of all milk and yogurt products included in our study. Contrary to our expectations, low-fat flavored milks and yogurts generally had moderately lower average sugar contents than regular-fat products, whereas low-fat unflavored milks and yogurts appear to have similar sugar contents to their regular-fat counterparts. Therefore, it appears that dairy manufacturers may modify the sugar content in their milk and yogurt products relatively independently of their fat content.

The present study has several strengths. Nutritional data were collected through the use of standardized methods with quality control measures to enhance data integrity. To date, studies on the sugar content of dairy products have been limited by small sample sizes in single countries (33–35). Our study builds on and substantially adds to the prior literature through the use of comprehensive datasets across 3 countries, which resulted in a large number of products and increased statistical power to assess differences in sugar content between countries and types of products.

Some limitations of this study need to be mentioned. Firstly, only products available for sale in major supermarkets are included, and therefore it is unlikely we have achieved complete coverage of all relevant products in each country. Nevertheless, data were collected from major supermarket chains with large market shares within each country, and it is likely the results provide a reasonable snapshot of the current packaged milk and yogurt products in each country. Furthermore, the data set did not capture information pertaining to the consistency of yogurts (e.g., liquid style, semisolid style) unless it was specified in the product name. As we did not identify any liquid yogurts or liquid yogurt products in the data set according to product name, all yogurts were classified as solid.

Information on the free or "added" sugar content is not currently mandatory on back-of-pack NIPs in Australia, England, and South Africa, and imputation based on subtracting intrinsic sugar content for milk and yogurt likely introduced some random error into our estimated free-sugar concentrations. A small number of milk ($n = 12$) and yogurt products ($n = 30$) were retailed across multiple countries. Due to the limited sample, we did not conduct further analyses on these products as it is unlikely we would have had sufficient power to detect a difference in sugar concentrations.

Because our analyses were limited to products available on supermarket shelves, we were unable to evaluate the impact of flavored milks and yogurts on total sugar purchases. Future research applying sales-weighted analyses are needed to assess the impact of both flavored and unflavored milk and yogurts on population exposure to sugar (55, 56). Food-purchase data would also allow for an objective evaluation of the effectiveness of the sugar reformulation targets in Australia and the United Kingdom (17–19) and its impact on total sugar purchases, and milk and yogurt sales. Additional research is also required to understand how factors such as product labeling, nutrient claims, and differential marketing of dairy products to adults and children influence consumer demand for these products.

In conclusion, the present paper demonstrates that flavored milks and yogurts are highly prevalent in supermarkets in middle- to high-income countries. Most contain high concentrations of both total and free sugar and could contribute significantly to daily sugar limits if consumed regularly.

Acknowledgments

We thank Maria Shahid, data analyst at the George Institute for Global Health, for her assistance with the statistical analyses. The authors' responsibilities were as follows—JHW, DHC, and SS: designed the research; DHC, SS, RN, and PH: conducted the research; DHC: analyzed the data; DHC, JHW, and SS: wrote the paper; DHC: had primary responsibility for final content; and all authors: have read and approved the final manuscript.

References

1. Malik V, Schulze M, Hu F. Intake of sugar-sweetened beverages and weight gain: a systematic review. Am J Clin Nutr 2006;84(2):274–88.
2. Gupta P, Gupta N, Pawar A, Birajdar S, Natt A, Singh H. Role of sugar and sugar substitutes in dental caries: a review. ISRN Dent 2013;2013:519421.
3. Touger-Decker R, van Loveren C. Sugars and dental caries. Am J Clin Nutr 2003;78(4):881S–92S.
4. Temple N. Fat, sugar, whole grains and heart disease: 50 years of confusion. Nutrients 2018;10(1):1–9.
5. Lean M, Morenga L. Sugar and type 2 diabetes. Br Med Bull 2016;120(1):43–53.
6. World Health Organization. Guideline: Sugars intake for adults and children [Internet]. 2015 [cited 19 December, 2018]. Available from: http://www.who.int/nutrition/publications/guidelines/sugars_intake/en/.
7. World Health Organization. WHO calls on countries to reduce sugars intake among adults and children [Internet]. 2015 [cited 19 December, 2018]. Available from: https://www.who.int/mediacentre/news/releases/2015/sugar-guideline/en/.
8. Newens K, Walton J. A review of sugar consumption from nationally representative dietary surveys across the world. J Hum Nutr Diet 2016;29(2):225–40.
9. Government of the United Kingdom. Healthy lives, healthy people: a call to action on obesity in England. London: UK Government; 2011.
10. Department of Health. Healthy food partnership [Internet]. 2016 [cited 17 September, 2018]. Available from: http://www.health.gov.au/internet/main/publishing.nsf/content/healthy-food-partnership.
11. Ndinda C, Ndhlovu TP, Juma P, Asiki G, Kyobutungi C. The evolution of non-communicable diseases policies in post-apartheid South Africa. BMC Public Health 2018.
12. World Health Organization. Noncommunicable diseases country profiles 2018: Australia [Internet]. 2018 [cited 16 April, 2019]. Available from: https://www.who.int/nmh/countries/2018/aus_en.pdf?ua=1.
13. World Health Organization. Noncommunicable diseases country profiles 2018: South Africa [Internet]. 2018 [cited 16 April, 2019]. Available from: https://www.who.int/nmh/countries/2018/zaf_en.pdf?ua=1.
14. World Health Organization. Noncommunicable diseases country profiles 2018: United Kingdom [Internet]. 2018 [cited 16 April, 2019]. Available from: https://www.who.int/nmh/countries/gbr_en.pdf.
15. HM Treasury. Soft drinks industry levy comes into effect. [Internet]. 2018 [cited 16 April, 2019]. Available from: https://www.gov.uk/government/news/soft-drinks-industry-levy-comes-into-effect.
16. Juma PA, Mohamed SF, Matanje Mwagomba BL, Ndinda C, Mapa-tassou C, Oluwasanu M, Oladepo O, Abiona O, Nkhata MJ, Wisdom JP, et al. Non-communicable disease prevention policy process in five African countries authors. BMC Public Health 2018;18(Suppl 1):961.
17. Department of Health. Healthy food partnership voluntary food reformulation targets—public consultation [Internet]. 2018 [cited September 17, 2019]. Available from: https://consultations.health.gov.au/population-health-and-sport-division-1/hfp-reformulation/consultation/.
18. Tedstone A, Targett V, Owtram G, Pyne V, Allen R, Bathrellou K, et al. Sugar reduction: achieving the 20%. A technical report outlining progress to date, guidelines for industry, 2015 baseline levels in key foods and next steps. London: Public Health England; 2017.
19. Tedstone A, Owtram G, Montel S, O'Kennedy E, Coulton V, Targett V, et al. Sugar reduction: juice and milk based drinks. A technical report outlining guidelines for industry, 2017 baseline levels for drinks in scope and next steps. London: Public Health England; 2018.
20. National Health and Medical Research Council (NHMRC). Australian dietary guidelines. Canberra: NHMRC; 2013.
21. Olivares L, Burns-Whitmore B, Kessler L. Retaining hispanic dietetic undergraduate students through mentoring and professional development. J Acad Nutr Diet 2015;115(5):S10–S5.
22. Public Health England. The eatwell guide. London: Public Health England; 2016.
23. Parker C, Vivian W, Oddy W, Beilin L, Mori T, O'Sullivan T. Changes in dairy food and nutrient intakes in Australian adolescents. Nutrients 2012;4(12):1794–811.
24. Mozaffarian D, Wu JHY. Flavonoids, dairy foods, and cardiovascular and metabolic health: a review of emerging biologic pathways. Circ Res 2018;122(2):369–84.
25. Elwood P, Pickering J, Givens D, Gallacher J. The consumption of milk and dairy foods and the incidence of vascular disease and diabetes: an overview of the evidence. Lipids 2010;45:925–39.
26. Australian Food News. Yoghurt growth opportunities fuelled by global lifestyle differences, market research [Internet]. 2015 [cited 17 September, 2018]. Available from: http://www.ausfoodnews.com.au/2015/02/18/yoghurt-growth-opportunities-fuelled-by-global-lifestyle-differences-market-research.html.
27. FoodDive. Global flavoured milk market overview 2018: share, growth, demand and forecast research report to 2023 [Internet]. 2018 [cited 7 September, 2018]. Available from: https://www.fooddive.com/press-release/20180304-global-flavoured-milk-market-overview-2018-share-growth-demand-and-forec/.
28. Mordor Intelligence. Yogurt market–segmented by application and geography – growth, trends, and forecast (2018–2023) [Internet]. 2018 [cited 19 December, 2018]. Available from: https://www.mordorintelligence.com/industry-reports/yogurt-market.
29. MarketWatch. Global flavored milk market growth is expected to be driven by changing consumers taste and preferences [Internet]. 2018 [cited 21 December, 2018]. Available from: https://www.marketwatch.com/press-release/global-flavored-milk-market-growth-is-expected-to-be-driven-by-changing-consumers-taste-and-preferences-2018-06-18.
30. Goldfein K, Slavin J. Why sugar is added to food: Food Science 101. Compr Rev Food Sci Food Saf 2015;14(5):644–56.
31. Johansen S, Næs T, Øyaas J, Hersleth M. Acceptance of calorie-reduced yoghurt: effects of sensory characteristics and product information. Food Qual Prefer 2010;21(1):13–21.
32. Chollet M, Gille D, Schmid A, Walther B, Piccinali P. Acceptance of sugar reduction in flavored yogurt. J Dairy Sci 2013;96(9):5501–11.

33. Wierzejska R, Siuba-Strzelińska M, Jarosz M. Evaluation of dairy products available on the Polish market in the context of nutrient profiles: clear arguments for reformulation of foodstuffs. Rocz Panstw Zakl Hig 2017;68(1):43–50.
34. Bernstein J, Schermel A, Mills C, L'Abbé M. Total and free sugar content of Canadian prepackaged foods and beverages. Nutrients 2016;8(9):1–22.
35. Zupanič N, Miklavec K, Kušar A, Žmitek K, Fidler M, Pravst I. Total and free sugar content of pre-packaged foods and non-alcoholic beverages in Slovenia. Nutrients 2018;10(2):E151.
36. Dunford E, Webster J, Metzler A, Czernichow S, Ni Mhurchu C, Wolmarans P, Snowdon W, L'Abbe M, Li N, Maulik PK, et al. International collaborative project to compare and monitor the nutritional composition of processed foods. Eur J Prev Cardiol 2012;19(6):1326–32.
37. Peters S, Dunford E, Ware L, Harris T, Walker A, Wicks M, vanZyl T, Swanepoel B, Charlton KE, Woodward M, et al. The sodium content of processed foods in South Africa during the introduction of mandatory sodium limits. Nutrients 2017;9(4):1–15.
38. Dunford Neal. FoodSwitch: a mobile phone app to enable consumers to make healthier food choices and crowdsourcing of national food composition data. J Food Compost Anal 2017;64(1):13–7.
39. Walker K, Woods J, Ross J, Hechtman R. Yoghurt and dairy snacks presented for sale to an Australian consumer: are they becoming less healthy? Public Health Nutr 2009;13(7):1036–41.
40. Food Standards Australia New Zealand (FSANZ). AUSNUT 2011–13 Food Nutrient Database [Internet]. 2011–13 [cited 20 December, 2018]. Available from: http://www.foodstandards.gov.au/science/monitoringnutrients/ausnut/ausnutdatafiles/Pages/foodnutrient.aspx.
41. Department of Health. Guide to creating a front of pack (FoP) nutrition label for pre-packed products sold through retail outlets [Internet]. 2016 [cited 20 December, 2018]. Available from: https://www.food.gov.uk/sites/default/files/media/document/fop-guidance_0.pdf.
42. Bucher T, Collins C, Rollo M, McCaffrey T, De Vlieger N, Van der Bend D, Truby H, Perez-Cueto FJ. Nudging consumers towards healthier choices: a systematic review of positional influences on food choice. Br J Nutr 2016;115(12):2252–63.
43. Walmsley R, Jenkinson D, Saunders I, Howard T, Oyebode O. Choice architecture modifies fruit and vegetable purchasing in a university campus grocery store: time series modelling of a natural experiment. BMC Public Health 2018;18(1):1–9.
44. Benson T, Lavelle F, Bucher T, McCloat A, Mooney E, Egan B, Collins CE, Dean M. The impact of nutrition and health claims on consumer perceptions and portion size selection: results from a nationally representative survey. Nutrients 2018;10(5):E656.
45. Ni Mhurchu C, Eyles H, Jiang Y, Blakely T. Do nutrition labels influence healthier food choices? Analysis of label viewing behaviour and subsequent food purchases in a labelling intervention trial. Appetite 2018;121: 360–5.
46. Cecchini M, Warin L. Impact of food labelling systems on food choices and eating behaviours: a systematic review and meta-analysis of randomized studies. Obes Rev 2016;17(3):201–10.
47. Talati Z, Norman R, Pettigrew S, Neal B, Kelly B, Dixon H, Ball K, Miller C, Shilton T. The impact of interpretive and reductive front-of-pack labels on food choice and willingness to pay. Int J Behav Nutr Phys Act 2017;14: 171.
48. Hashem K, He F, MacGregor G. Effects of product reformulation on sugar intake and health—a systematic review and meta-analysis. Nutr Rev 2019;77(3):181–96.
49. Yeung CHC, Gohil P, Rangan AM, Flood VM, Arcot J, Gill TP, Louie CYJ. Modelling of the impact of universal added sugar reduction through food reformulation. Sci Rep 2017;7(1):17392.
50. Briggs A, Mytton O, Kehlbacher A, Tiffin R, Elhussein A, Rayner M. Health impact assessment of the UK soft drinks industry levy: a comparative risk assessment modelling study. Lancet Public Health 2017;2(1):e15–22.
51. Crino M, Herrera AMM, Ananthapavan J, Wu JHY, Neal B, Lee YY, Zheng M, Lal A, Sacks G. Modelled cost-effectiveness of a package size cap and a kilojoule reduction intervention to reduce energy intake from sugar-sweetened beverages in Australia. Nutrients 2017;9(9):1–17.
52. Ma Y, He F, Yin Y, Hashem K, MacGregor G. Gradual reduction of sugar in soft drinks without substitution as a strategy to reduce overweight, obesity, and type 2 diabetes: a modelling study. Lancet Diabetes Endocrinol 2016;4(2):105–14.
53. Hendriksen M, Tijhuis M, Fransen H, Verhagen H, Hoekstra J. Impact of substituting added sugar in carbonated soft drinks by intense sweeteners in young adults in the Netherlands: example of a benefit-risk approach. Eur J Nutr 2011;50:41–51.
54. Drouin-Chartier J, Côté J, Labonté M, Brassard D, Tessier-Grenier M, Desroches S, Couture P, Lamarche B. Comprehensive review of the impact of dairy foods and dairy fat on cardiometabolic risk. Adv Nutr 2016;7(6):1041–51.
55. Ni Mhurchu C, Capelin C, Dunford E, Webster JL, Neal BC, Jebb SA. Sodium content of processed foods in the United Kingdom: analysis of 44,000 foods purchased by 21,000 households. Am J Clin Nutr 2011;93(3):594–600.
56. Bandy L, Adhikari V, Jebb S, Rayner M. The use of commercial food purchase data for public health nutrition research: a systematic review. PloS ONE 2019;14(1):e0210192.