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Added, free and total sugar content and consumption of foods and beverages in Canada

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ABSTRACT

Background

Consumption of sugars contributes to obesity and various chronic diseases. The U.S. Department of Agriculture and the World Health Organization recommend that added and free sugar consumption be less than 10% of total energy intake (TEI). However, in Canada, the added and free sugar content of foods and beverages is not documented, so Canadians' consumption and compliance with the above recommendations are unknown.

Data and methods

This study calculated the added and free sugar content of all 5,374 foods and beverages recorded in the 24-hour dietary recalls of the 2015 Canadian Community Health Survey – Nutrition using established procedures. The usual intake of added, free and total sugars was estimated with the National Cancer Institute method.

Results

In 2015, residents of Canada consumed an average of 57.1 g/day of added sugars, 67.1 g/day of free sugars and 105.6 g/day of total sugars. This represented 11.1%, 13.3% and 21.6% of TEI for added, free and total sugar intake, respectively. Among all Canadians, 49.0% consumed less than 10% of TEI from added sugars, while 33.8% consumed less than 10% of TEI from free sugars. The food groups with the highest added and free sugar content were desserts and sweets, breakfast cereals, baked products, beverages, and snacks. Desserts and sweets and beverages were the two main contributors of sugar in the Canadian diet.

Interpretation

The majority of Canadians consumed more added and free sugars than recommended. Estimating added and free sugar content and consumption could help researchers assess the health of Canadians and the economic burden of excessive sugar consumption and could help policy makers articulate intervention targets.

Keywords

Sugars, dietary intake, energy intake, recommended dietary allowances, disease prevention, obesity, chronic disease, public health, Canada

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What is already known on this subject?

- Excessive sugar consumption increases the risk of obesity and various chronic diseases.
- Various countries have estimated added and free sugar consumption and proposed or introduced interventions to reduce the consumption of these sugars.
- In Canada, the added and free sugar content of foods and beverages is not systematically documented; therefore, consumption and the potential benefits of interventions are unknown.

What does this study add?

- This study documents the added and free sugar content of all food items recorded in the 2015 Canadian Community Health Survey – Nutrition.
- The majority of Canadians consume more added and free sugars than recommended.
- Added and free sugar value and consumption estimates could facilitate future research into the potential benefits of interventions targeting added or free sugar consumption.

In Canada, chronic diseases account for 89% of all deaths¹ and more than \$80 billion in annual health care costs.² Adopting healthy lifestyle behaviours, such as healthy eating, has the potential to prevent 80% of type 2 diabetes and cardiovascular disease, 40% of cancers, and other chronic diseases.^{1,3} Despite healthy eating recommendations issued by Health Canada,⁴ eating habits continue to deteriorate, and overweight prevalence rates continue to increase.⁵

Since sugars contribute to the overall energy composition of diet, excess sugar intake may lead to a positive energy balance and weight gain. Considerable epidemiological and experimental evidence has emerged suggesting an association between sugar consumption and obesity, high blood lipid levels, visceral adiposity, fatty liver disease, insulin resistance, type 2 diabetes, cardiovascular disease, metabolic syndrome, and dental caries.⁶⁻¹³ While nutritious foods like fruits and milk contain naturally occurring sugars,¹⁴ many other foods and beverages contain added and free sugars that, when consumed in excess amounts, increase calorie intake and displace consumption of nutritious foods.¹⁵

The definitions of added, free and total sugars vary. This study uses the World Health Organization (WHO) definition of free sugars: “all monosaccharides and disaccharides added to foods by the manufacturer, cook or consumer, and sugars naturally present in honey, syrups, fruit juices and fruit juice concentrates.”⁶ Added sugars are defined as refined sugars added during cooking or manufacturing, not including naturally occurring sugars and fruit juice.^{16,17} Total sugars are defined as the sum of all naturally occurring and added sugars.

In 2015, the WHO released new recommendations to reduce the consumption of free sugars to less than 10% of daily total energy intake (TEI), and ideally to less than 5% of TEI to achieve

additional health benefits.⁶ The 2015-to-2020 edition of *Dietary Guidelines for Americans*, released by the U.S. Department of Agriculture (USDA), recommends that Americans consume less than 10% of calories from added sugars.

Various countries have documented added and free sugar consumption. For example, in the United States, added sugars were estimated to comprise 13.1% to 17.5% of TEI among children and 11.2% to 14.5% of TEI among adults.^{18,19} Children in Greece were estimated to obtain 11.2% of TEI from free sugars.²⁰ These population averages exceed the sugar recommendations of the WHO and the USDA and call for interventions to reduce added and free sugar intake. Estimates of added and free sugar consumption are not available for Canada because the added and free sugar content of foods and beverages in Canada is not systematically documented.

In 2004, the average total sugar intake of Canadians was estimated to be 21.4% of daily TEI,²¹ an estimate that includes both naturally occurring and added sugars. While subsequent work was done to quantify added sugar intake specifically, these estimates did not consider all sources of added sugars.²² Research showed that 66% of 40,000 packaged food products in Canada contained at least one added sugar.²³ In a recent study, Bernstein et al.²⁴ estimated the free sugar content of prepackaged foods in Canada using the Food Label Information Program. Although the authors were able to estimate the free sugar content for a large number of prepackaged foods, their work did not include all dietary sources. Therefore, to date, there are no accurate population-based estimates of the added and free sugar content of the Canadian diet.

Given the increasing concerns about the health consequences of excess added and free sugar intake, there is growing interest in applying policies and programs to reduce this consumption.

Various jurisdictions have introduced such policies and programs to reduce consumption at the population level.^{25,26} For Canada, scientific research into the health effects of excess added and free

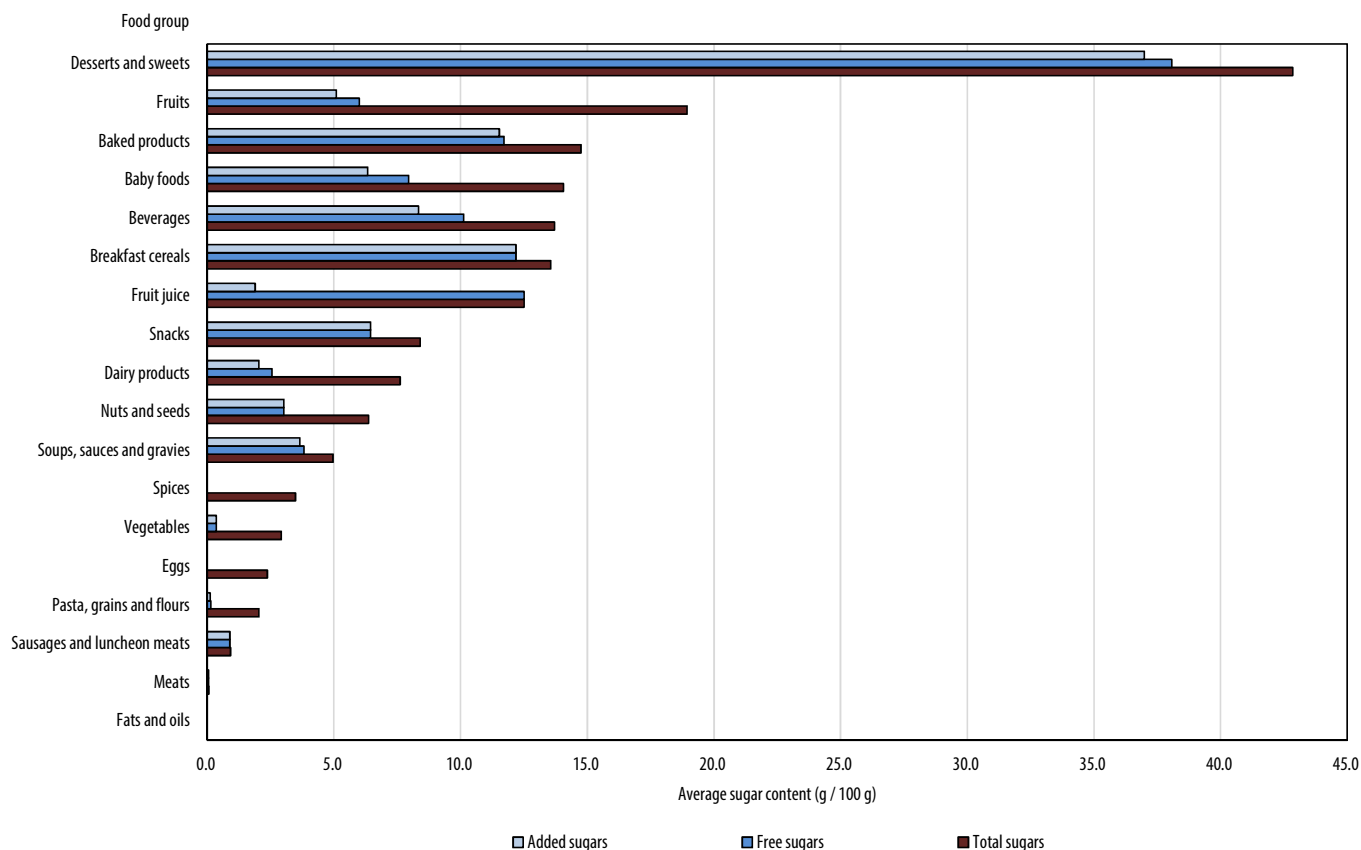
sugar consumption and the potential benefits of interventions starts with a good understanding of added and free sugar consumption at the population level. Therefore, to provide

Figure 1
Decision flow chart of a 9-steps approach to assigning added and free sugar content



Notes: n_{as}: the number of food items for added sugar; n_{fs}: the number of food items for free sugar.
Source: Author's compilation based on the 2015 Canadian Community Health Survey - Nutrition content.

Figure 2
Estimated added, free and total sugar content (g / 100 g) of food groups in Canada



Source: Author's compilation based on the 2015 Canadian Community Health Survey - Nutrition content.

accurate sugar consumption information for researchers and policy makers, this study aims (1) to document the added, free and total sugar content of foods and beverages consumed in Canada; and (2) to estimate the consumption and dietary sources of added, free and total sugars in Canada.

Data and methods

Data sources

The 2015 Canadian Community Health Survey (CCHS) – Nutrition is a cross-sectional national survey that was conducted by Statistics Canada and Health Canada from January to December 2015. The survey recruited individuals aged 1 and older living in private dwellings in the 10 Canadian provinces using a multi-stage, clustered design.²⁷ A national response rate of 61.6% was achieved. The survey's 24-hour dietary recall collected the food intakes of 20,487 respondents, 7,608 of whom completed a second 24-hour dietary recall. These 24-hour dietary recalls were administered using an Automated Multiple-Pass Method.²⁸ Respondents reported the consumption of 2,784

ingredient-level foods and 2,590 recipe-level foods in the 2015 CCHS – Nutrition. Recipe-level foods are foods that consist of two or more ingredients. A sandwich and Caesar salad are examples of recipe-level foods, and an apple and noodles are examples of ingredient-level foods.²⁷ The nutrient content of ingredient-level foods was used to calculate the nutrient content of recipe-level foods. The Canada Food Guide file was used to determine the serving sizes.²⁸

The University of Alberta Research Ethics Board approved this study (Pro00073295). The 2015 CCHS – Nutrition data were accessed through Statistics Canada's Research Data Centres Program.

Estimation of the added and free sugar content of foods and beverages

Statistics Canada calculated the nutrient intake, including total sugar intake, for respondents based on the consumption and nutrient content of the reported foods and beverages. However, this calculation does not include added and free sugar intake, as

the added and free sugar content of foods and beverages is not systematically documented in Canada.

In 2015, Louie et al.¹⁷ published a decision tree with a systematic methodology to estimate the added sugar content of foods in Australia. Their 10-step standardized approach had high inter-rater repeatability and was designed for both national (Australia) and international use.¹⁷ The approach by Louie et al.¹⁷ was adapted for use in Canada. Figure 1 illustrates the decision algorithm of the nine-step approach. Note that 1 of the 10 steps from the Louie et al. approach (step number 4) was omitted because recipe-level foods in the 2015 CCHS – Nutrition dataset used more than one recipe. A brief description of each of the nine steps is provided below. More details on each of the steps are provided elsewhere.²⁹

Step 1: Assign 0 g of added and free sugars for ingredient-level foods that contain 0 g in total sugars.

Step 2: Assign 0 g of added and free sugars for ingredient-level foods that are unprocessed or processed without added or free sugars.

Assign 0 g of added sugars for food types such as unsweetened fruit or vegetable juice (including concentrate), unsweetened dairy products, and all fats and oils. Assign 0 g of free sugars for these food types, except for fruit juice and foods with fruit juice.

Step 3: Assign 100% of total sugars as added and free sugars for ingredient-level foods with very little naturally occurring sugars.

Assign 100% of total sugars as added sugars for food types such as sugar-sweetened beverages, confectionery, sugars, syrups and

sweetener without added fruits, chocolate, and dairy products. Assign 100% of total sugars as free sugars for these food types and for 100% fruit juice and foods that contain fruits.

Step 4: Calculate added and free sugar content by comparing the total sugar content of a food or beverage with the sugar content of an unsweetened version of this food or beverage.

Added sugars and free sugars per 100 g (AS_{100g} and FS_{100g}) were calculated using the following formulas:

$$AS_{100g} = \frac{100 \times (TS_s - TS_{us})}{(100 - TS_{us})}, \text{ and}$$

$$FS_{100g} = \frac{100 \times (TS_s - TS_{us})}{(100 - TS_{us})},$$

where TS_s is the total sugar content per 100 g of the sweetened food or beverage, and TS_{us} is the total sugar content per 100 g of the unsweetened food or beverage.

Step 5: Calculate added and free sugar content based on lactose and maltose content.

Where data for lactose and maltose were available in the Canadian Nutrient File or the USDA Food Composition Database, added sugar and free sugar content of ingredient-level foods was calculated using the following formulas:

$$AS_{100g} = TS_{100g} - \text{lactose}_{100g} - \text{maltose}_{100g}, \text{ and}$$

$$FS_{100g} = TS_{100g} - \text{lactose}_{100g} - \text{maltose}_{100g}.$$

Table 1
Added, free and total sugar content of selected ingredient-level foods

Food name	Added sugars (g / 100 g)	Free sugars (g / 100 g)	Total sugars (g / 100 g)
Ravioli, cheese-filled with marinara sauce	2.0	2.2	4.5
Granola bar, chewy, fruit flavour, yogurt coated	18.2	25.3	34.1
Cereal, hot, oats, instant, flavoured, dry	0.7	0.7	1.4
Dessert, frozen, ices, water, lime	30.5	32.6	32.6
Yogurt, goat, fruit flavoured	4.8	7.3	9.6
Juice drink, cranberry and apricot, bottled	0.0	14.6	14.6
Spread, 20% butter / 80% canola oil	0.0	0.0	0.0
Mollusks, oyster, eastern (blue point), wild, raw	0.0	0.0	0.6
Deli meat, salami (Hungarian), pork and beef, cooked	0.8	0.8	0.8
Nuts, almonds, toasted, unblanched	0.0	0.0	4.8
Beans, baked, canned, with pork and tomato sauce	5.1	5.7	5.7
Cherry, sweet, canned, juice pack, solids and liquid	0.0	4.5	12.3
Snacks, plantain chips	0.5	0.5	0.9
Pomegranate juice, ready-to-drink	0.0	12.7	12.7
Soup, tomato rice, canned, condensed, water added	1.8	3.0	3.0
Baby food, cereal, rice, with milk powder and fruit, dry	14.5	16.3	29.1
Spices, onion powder	0.0	0.0	6.6
Egg, chicken, dried, whole	0.0	0.0	0.3

Notes: A table with added, free and total sugar content of all 2,784 ingredient-level foods recorded in the 2015 Canadian Community Health Survey – Nutrition is available elsewhere [29]. In addition to added sugars and free sugars, total sugars include mostly naturally occurring sugars such as lactose, fructose and maltose (see text and [29] for details).

Source: Author's compilation based on the 2015 Canadian Community Health Survey - Nutrition content.

Step 6: Calculate added sugar and free sugar content using the content values of similar foods from steps 1 to 5 or other nutrient databases.

Similar foods captured in steps 1 to 5 and in the Australian Food, Supplement and Nutrient Database were searched for information on added and free sugars. Foods were considered to be similar if they differed only in water content, if they contained similar ingredients (such as similar vegetables in soup), or if they were reduced in calories or energy or fat. Where a similar food was identified (matching), the added and free sugar content of the target food was estimated using the following formulas:

$$AS_{\text{target}} = TS_{\text{target}} \times (AS_{\text{matching}}/TS_{\text{matching}}),$$

$$\text{and } FS_{\text{target}} = TS_{\text{target}} \times (FS_{\text{matching}}/TS_{\text{matching}}).$$

Step 7: Estimate added and free sugar content for ingredient-level foods subjectively based on common recipes and ingredient lists.

Step 8: Assign 50% of total sugars as added and free sugar content for all remaining ingredient-level foods.

Step 9: Calculate added and free sugar content for recipe-level foods using respondent-specific recipes and the above estimated added and free sugar content of ingredient-level foods.

After all ingredient-level foods in the 2015 CCHS – Nutrition were estimated (steps 1 to 8), the added and free sugar content of recipe-level foods was calculated using the following formulas:

$$AS_{100g} = \frac{\sum_{i=1}^j RW_i \times AS_i}{\sum_{i=1}^j W_i} \text{ and } FS_{100g} = \frac{\sum_{i=1}^j RW_i \times FS_i}{\sum_{i=1}^j W_i},$$

where RW_i is the raw weight of the i th ingredient in the recipe, W_i is the weight of the i th ingredient in the recipe after cooking, AS_i is the added sugar content per 100 g of the i th ingredient and FS_i is the free sugar content per 100 g of the i th ingredient.

The average added and free sugar content of ingredient-level foods was calculated for 18 food groups (displayed in Figure 2). These food groups were based on the Bureau of Nutritional Sciences Food Group Codes and Descriptions³⁰ and the Canadian Nutrient File food groups.³¹

Estimation of usual intake of added, free and total sugar

The National Cancer Institute (NCI) method was applied to estimate the distribution of usual intake of added, free and total sugar by Canadians.³² The NCI method assumes that usual intake is equal to the probability of consumption on a given day times the average amount consumed on a “consumption day”³³ and uses repeated 24-hour recalls. Depending on whether certain nutrients are commonly consumed (i.e., daily and by most respondents), this method uses either a one-part or a two-part model.³⁴ The one-part model considers only the amount of a nutrient consumed and is to be applied to nutrients that are commonly consumed. The two-part model considers both the proportion of the population consuming the nutrient and the amount of the nutrient consumed, and it is to be applied to nutrients that are not commonly consumed. This study assumed that added, free and total sugars were consumed daily and by all members of the population. For the usual intake of added, free and total sugars for each of the 18 food groups, this study considered the proportion of the population that consumed no sugar. A one-part model was applied for food groups where less than 5% of the population consumed no sugar. A two-part model was applied for food groups where more than 20% of the population consumed no sugar. For food groups where 5% to 20% of the population consumed no sugar, both models were fitted, and the model with the best fit was used.³⁴ For the usual intake of added and free sugars expressed as a percentage of TEI, an extension of the NCI method was used.^{34,35}

All analyses included age, sex, the sequence of 24-hour recalls (first recall versus second recall), and the 24-hour recall collection day of the week (weekdays, or Monday to Thursday, versus weekends, or Friday to Sunday) as covariates when accommodating individual-level and within-individual variation. Sampling weights provided by Statistics Canada were used to ensure study estimates apply to residents of Canada (for ease of presentation referred to as Canadians). All statistical analyses were performed using SAS (version 9.4, SAS Institute) software. SAS Macros of the NCI method were available online.³⁶

Table 2
The distribution of usual intake of added, free and total sugars and adherence to recommendations, Canada, 2015

	Mean	Percentile							Recommendations	
		5th	10th	25th	50th	75th	90th	95th	<5% TEI	<10% TEI
Added sugar intake (grams per day)	57.1	13.8	18.5	29.6	47.7	74.2	107.2	132.3
Free sugar intake (grams per day)	67.1	17.7	23.7	37.0	58.0	87.2	122.1	147.8
Total sugar intake [‡] (grams per day)	105.6	45.3	54.2	72.4	98.0	130.5	166.6	191.9
TEI ^{††} from added sugars (%)	11.1	3.8	4.9	7.1	10.1	14.1	18.4	21.4	...	49.0
TEI from free sugars (%)	13.3	4.9	6.2	8.7	12.3	16.8	21.6	24.9	5.4	33.8
TEI from total sugars (%)	21.6	11.3	13.0	16.3	20.6	25.8	31.5	35.3

... not applicable

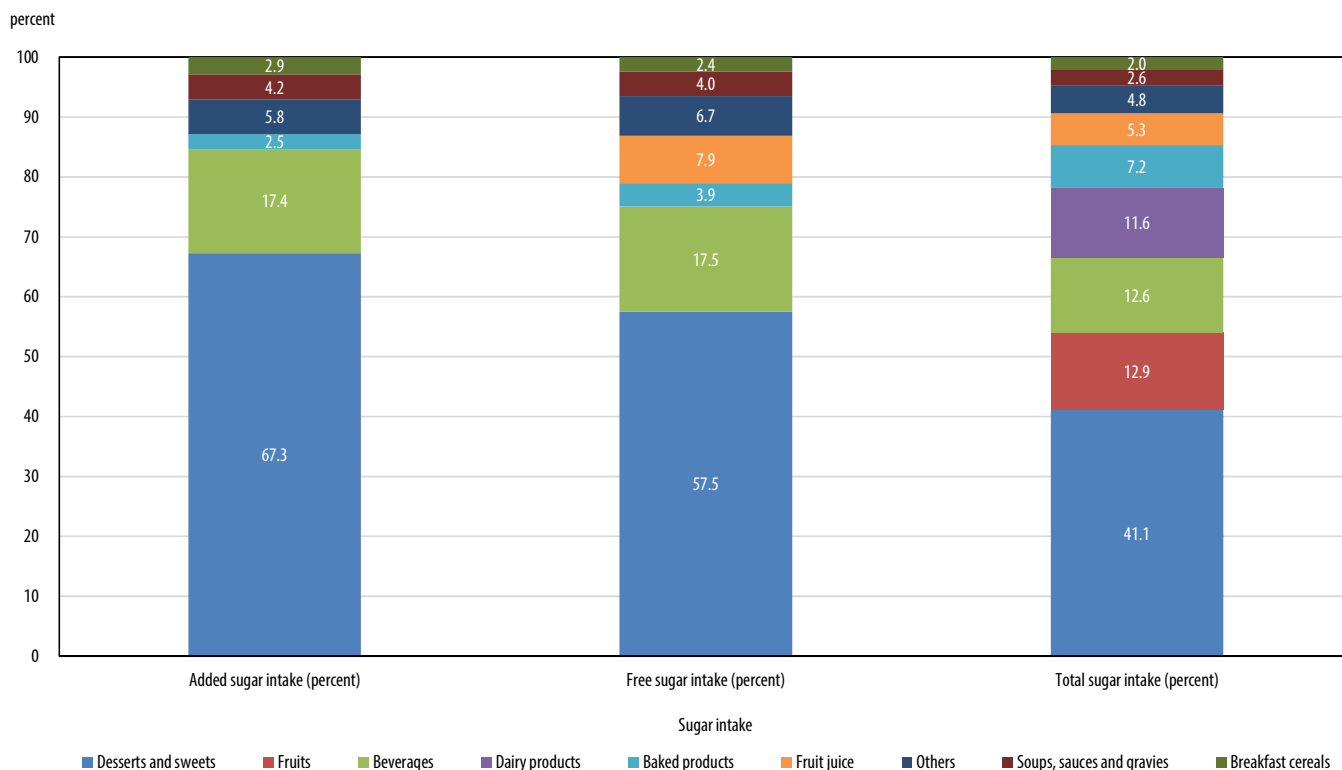
[‡] Total sugar intake, free sugar intake and added sugar intake were adjusted for inter-individual variation (sequence of the 24-hour recall and 24-hour recall collection day of the week) and for intra-individual variation (age and gender).

^{††} TEI: total energy intake.

Notes: The U.S. Department of Agriculture recommends that added sugar consumption not exceed 10% of TEI; the World Health Organization recommends that free sugar not exceed 5% and 10% of the TEI.

Source: Author's compilation based on the 2015 Canadian Community Health Survey - Nutrition content.

Figure 3
Contribution of food groups to the intake of added, free and total sugars in Canada



Source: Author's compilation based on the 2015 Canadian Community Health Survey - Nutrition content.

Results

Estimated added, free and total sugar content of foods and beverages

The added and free sugar content of 2,784 ingredient-level foods and 2,590 recipe-level foods consumed in Canada was calculated using the nine-step method. Table 1 shows the sugar content of selected ingredient-level food items recorded in the 2015 CCHS – Nutrition. The table provides one example for each of the 18 food groups. A table with the added, free and total sugar content of all ingredient-level foods is available elsewhere²⁹ for public use. Recipes (and recipe-level foods) are respondent-specific and subject to restricted release for confidentiality reasons, but they can be calculated from the ingredient-level foods.

Estimated added, free and total sugar content of food groups

For each of the 18 food groups, Figure 2 shows the average added, free and total sugar content of all foods and beverages reported by respondents. Desserts and sweets had the highest added, free and total sugar content, at 37.0, 38.1 and 42.9 g per

100 g, respectively. Except for fruits, all food groups high in total sugar also had high added and free sugar content. Breakfast cereals, baked products, beverages, baby foods and snacks were the food groups that contained high free and added sugar content. Fruit juice had high free sugar content (12.5 g / 100 g) but low added sugar content (1.9 g / 100 g). Fats and oils, meats, sausages and luncheon meats, pasta, grains and flours, eggs, vegetables, spices, soups, sauces and gravies, nuts and seeds, and dairy products had relatively low sugar content.

Estimated added, free and total sugar consumption and adherence to recommendations

Table 2 shows the mean and percentiles of usual added, free and total sugar intake in Canada. Canadians consume daily, on average, 57.1 g of added sugars, 67.1 g of free sugars and 105.6 g of total sugars. On average, added sugars constitute approximately 54.1% of total sugars, and free sugars make up approximately 63.5% of total sugars. The average estimated added, free and total sugar intake contributed to 11.1%, 13.3% and 21.6% of TEI, respectively.

A comparison between added and free sugar consumption and the recommended added and free sugar intake is also presented in Table 2. The USDA recommendation (added sugar intake below

10% of TEI) was met by 49.0% of Canadians. A lower percentage of Canadians adhered to the WHO recommendations for free sugars: free sugars made up less than 10% of TEI for 33.8% of Canadians; free sugars made up less than 5% of TEI for 5.4% of Canadians.

Contribution of food groups to added, free and total sugar intake

The contribution of each of the 18 food groups to added, free and total sugar intake is summarized in Figure 3. Desserts and sweets and beverages were the two food groups that contributed the most to added, free and total sugar intake in the Canadian diet. An estimated 67.3%, 57.5% and 41.1% of added, free and total sugar intake, respectively, came from desserts and sweets, and an estimated 17.4%, 17.5% and 12.6% of added, free and total sugar intake, respectively, came from beverages. Other food groups, such as baked products, soups, sauces and gravies, and breakfast cereals, also contributed to added, free and total sugar intake.

There were some differences in the relative contribution of food groups to the intake of added, free and total sugars (Figure 3). Fruits (12.9%) and dairy products (11.6%) were significant sources of total sugar intake, but not primary sources of added and free sugar intake.

Discussion

This study revealed the added, free and total sugar content and consumption of foods and beverages in Canada. For the majority of Canadians, consumption of added and free sugars exceeded USDA and WHO recommendations. Desserts and sweets and beverages contributed to most of the added, free and total sugar intake of Canadians.

Both the USDA's added sugar definition and the WHO's free sugar definition were applied in the present study. Added sugars differ from free sugars in their exclusion of naturally occurring sugars in fruit juices and fruit juice concentrates. Various studies have not clearly defined added and free sugars,^{17,18,19,24} whereas the present study and others^{37,38} have demonstrated substantial differences in the consumption of added versus free sugars.

Total sugar intake in Canada was estimated at 110.0 g/day using the 2004 CCHS – Nutrition.²¹ This seems higher than the 105.6 g/day that was estimated in this study using the 2015 CCHS – Nutrition. Langlois et al.,³⁹ who studied the temporal changes in total sugar consumption, concluded that the apparent reduction between 2004 and 2015 may actually be caused by misreporting as a result of changes in survey methodology. They also reported that total sugar consumption from foods actually increased between 2004 and 2015, while total sugar intake from beverages decreased.³⁹ Studies from other countries and of earlier time periods concluded that total sugar intake either decreased or levelled off, both in absolute terms (g/day) and in relative terms (percentage of total sugar in TEI).^{40,41,42}

To date, very few studies of added and free sugar consumption have been population-based, and very few have reported on compliance with USDA and WHO recommendations. Louie et al. found that 1% of Australian children and youth (aged 2 to 16) consumed added sugars below 5% of TEI, and 18.1% consumed added sugars below 10% of TEI.⁴² Sluik et al. revealed that 29% of Dutch residents (aged 7 and older) met the recommendation for added sugars (less than 10% of TEI) and 19% met the recommendation for free sugars (less than 10% of TEI).³⁸ The present study's estimates that 49.0% and 33.8% of Canadians met the existing recommendations for added and free sugars, respectively, are notably higher than these Australian and Dutch estimates.

This study revealed that desserts and sweets, breakfast cereals, baked products, beverages, and snacks are food groups with high added and free sugar content. This ranking seems consistent with the ranking by Bernstein et al. for prepackaged foods and beverages.²⁴ This study also showed that the intake of added, free and total sugars through desserts and sweets was substantially higher than the intake of these sugars through beverages. This appears to be consistent with observations from a review of 11 European studies that concluded that sweet products contributed to a higher proportion of added sugar intake (40% to 50% for children and 36% to 61% for adults) than beverages did (20% to 34% for children and 12% to 31% for adults).⁴³

Various countries and jurisdictions have adopted strategies to improve diet quality or reduce energy intake. These include food guides, school nutrition policies, front-of-package labelling, social marketing and various forms of taxation.^{4,25,44,45} Several studies have reported on the effectiveness of these interventions and the extent to which they resulted in a decrease in added and free sugar consumption.^{26,46,47} However, other studies have shown that there remains plenty of room for improvement. For example, economic evaluations revealed that Canada would have avoided health care costs of approximately \$863 million in 2014 and \$830 million in 2018 if Canadians had avoided consuming sugar-sweetened beverages.^{48,49} The present study's added and free sugar value and consumption estimates may support future research into the health and economic costs associated with the consumption of these sugars. They may also inform potential intervention targets for added and free sugar consumption.

The present study has several strengths. It uses the 2015 CCHS – Nutrition, which is a large population-based survey that included the 24-hour recall data of more than 20,000 respondents, with repeat measures, to allow for the estimation of usual intake. A study limitation relates to the subjective judgment used in steps 6, 7 and 8, as this may have introduced error in the estimates of added and free sugar content. However, these steps did involve a limited number of foods and beverages: Figure 1 shows that they involved 475 (8.8%) of the 5,374 recorded foods and beverages when estimating added sugars and 397 (7.4%) of the foods and beverages when estimating free sugars. In addition, Louie et al.¹⁷ reported high inter-rater repeatability for this methodology. Another limitation relates to the use of 24-hour recalls, which are prone to error, as is every dietary assessment method.

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