

## Relationship between energy from added sugars and frequency of added sugars intake in Irish children, teenagers and adults

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A WHO report on diet, nutrition and the prevention of chronic diseases recommended that frequency of consumption of foods and/or drinks containing free sugars should be limited to a maximum of four times per d. In addition, they recommended a reduction in the intake of free sugars to a maximum of no more than 10% of energy intake. These recommendations were developed with the aim of reducing the prevalence of dental caries. The aim of the present study was to establish if there is a quantitative relationship between energy from added sugars and frequency of added sugars intakes in Irish children, teenagers and adults. In addition, the intake of added and total sugars and main contributors to added sugar intakes were examined. Data for the present analysis were based on the North/South Ireland Food Consumption Survey (*n* 1379; aged 18–64 years), the National Children's Food Survey (*n* 594; aged 5–12 years) and the National Teen Food Survey (*n* 441; aged 13–17 years) which used 7 d food diaries to collect food and beverage intake data in representative samples of Irish adults, children and teenagers respectively. Results showed that in adults, frequency of intake of added sugar intake of four times per d corresponded to a mean added sugar intake of 9%, which was similar to the WHO recommendation. In children and teenagers, a frequency of intake of four times per d corresponded to a mean added sugar intake of 14.6 and 12.4% respectively and was therefore not in agreement with the WHO recommendation.

### Added sugar: Eating occasions: Contributors to added sugars intakes

Numerous countries have established recommendations on the maximum intake of added sugars or non-milk extrinsic sugars (NMES) based on the documented relationship with dental caries formation. In the UK, the recommendation for the total population is that NMES sugars intakes should be kept below 60 g/d, which relates to  $\leq 10\%$  total energy ( $\leq 11\%$  food energy)<sup>(1)</sup>.

A WHO report on diet, nutrition and the prevention of chronic diseases found that the best available evidence indicates that the level of dental caries is low in countries where the consumption of free sugars is  $< 15\text{--}20\text{ kg/year}$  (40–55 g/d). This relates to 6–10% of energy intake and approximately ten to fourteen level teaspoons of sugar (one level teaspoon contains 4 g sugar and 67 kJ (16 kcal))<sup>(2)</sup>. The report also highlighted that in addition to population targets given in terms of the amount of free sugars, targets for the frequency of consumption of foods containing free sugars are important. The report presented several studies<sup>(3–6)</sup> which indicate that when the frequency of sugar intake exceeds four times per d, there is a marked increase in caries prevalence. Based on these findings, the recommendations on sugar intakes given in the report also advises that frequency of consumption of foods and/or drinks containing free sugars should be limited to a maximum of four times per d.

To the best of our knowledge, no other study has examined the quantitative relationship between 10% total energy from added sugars and frequency (four times per d) of added sugar intakes in children, teenagers and adults. The aims of the present paper are to assess the frequency of consumption of added sugars in Irish children, teenagers and adults and to determine if there is a quantitative relationship between 10% total energy from added sugar and frequency (four times per d) of added sugar intake.

### Methods

#### Population samples

The analysis for the present paper is based on data from the cross-sectional North/South Ireland Food Consumption Survey (NSIFCS), the National Children's Food Survey (NCFS) and the National Teen Food Survey (NTFS). The NSIFCS (1997–9), NCFS (2003–4) and NTFS (2005–6) were carried out on representative samples of Irish adults (aged 18–64 years; *n* 1379), children (aged 5–12 years; *n* 594) and teenagers (aged 13–17 years; *n* 441) respectively. A more detailed account of the sampling methods and methodology used in the NSIFCS<sup>(7,8)</sup> and the NCFS<sup>(9)</sup> are available elsewhere.

**Abbreviations:** NCFS, National Children's Food Survey; NMES, non-milk extrinsic sugars; NSIFCS, North/South Ireland Food Consumption Survey; NTFS, National Teen Food Survey; RTEBC, ready-to-eat breakfast cereal.

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### *Data collection in the National Teen Food Survey*

A 7 d food diary was used to collect food and beverage intake data. During the 7 d period the researcher made four visits to the respondent: a training visit to show how the food diary was kept; a second visit 24–36 h into the recording period to review the diary, check for completeness and clarify details regarding specific food descriptors and quantities; a third visit 4 or 5 d into the recording period to check the previous 2 or 3 d and to encourage completion; a final visit 1 or 2 d after the recording period to check the last days and to collect the diary.

The respondents were asked to record detailed information regarding the types and amounts of all foods, beverages and nutritional supplements consumed over the 7 d period, the cooking method used (where applicable), the brand name of foods (where appropriate), details of recipes and any leftovers and food packaging information. Data were also collected on the time of each eating or drinking occasion, the respondent's definition of each eating or drinking occasion (for example, morning snack, lunch, etc) and the location of the preparation or source of the meal or snack consumed (for example, home, work, takeaway, etc). Self-administered questionnaire data were obtained on socio-demographic factors and health and lifestyle parameters. The division of the sample into social-class groups was based on the parents' occupation (including last main occupation for those not working or retired). All subjects were classified according to the Central Statistics Office, Census 2002 Occupations<sup>(10)</sup>.

### *Food quantification in the National Teen Food Survey*

On the basis that different foods are best quantified using different methods and some methods of quantification are more precise than others, a hierarchical approach to food quantification was used as follows:

- (1) Portable food scales (Tanita, Japan) were given to each respondent. The fieldworker gave detailed instructions as to how to use the food scales to respondents and/or parents or guardians during the training session on the first visit. This included a demonstration where the researcher weighed typical portions of certain foods and beverages, particularly those that were consumed most commonly (for example, ready-to-eat breakfast cereals (RTEBC), homemade bread) as defined by each subject;
- (2) a photographic food atlas developed by the Food Standards Agency in the UK was used to quantify food and beverages<sup>(11)</sup>;
- (3) suggested serving sizes indicated on food labels;
- (4) a database of average portions of certain foods (for example, sliced meats, takeaway foods) was compiled by the research team;
- (5) food weights and average food portion sizes estimated for UK adults by the Ministry of Agriculture, Fisheries and Food<sup>(12)</sup>;
- (6) household measures;
- (7) the researcher estimated portion sizes based on the respondents' eating patterns.

In the event that a quantity was not assigned to a given eating occasion by the respondent, the weight of food eaten on previous occasions by the respondent was used.

### *Estimation of nutrient intake in the National Teen Food Survey*

Food intake data were analysed using WISP© (Tinuviel Software, Warrington, UK). WISP© uses data from McCance and Widdowson's *The Composition of Foods*, fifth<sup>(13)</sup> and sixth editions<sup>(14)</sup> plus supplemental volumes<sup>(15–23)</sup> to generate nutrient intake data. The food consumption database generated from the survey listed each individual food item as consumed by each respondent together with the nutrient composition for the quantity of each food consumed.

### *Validation of food intake data*

Several steps were taken to ensure the validity of the food intake data. At the end of the survey week the teenager was asked if his/her food intake was the same as usual, less than usual or more than usual during the preceding week. If their intake was different to usual the teenager was asked if they were unwell, if it was not a typical week for them or if there was another reason for the unusual pattern of food intake. The teenager was also asked if they were on a weight-reducing or -gain diet while participating in the survey. Furthermore, the teenager was asked if there was any food or drink consumed during the 7 d that was not written down. If the teenager answered yes to this question, the fieldworker recorded the day and time of the foods and drinks consumed. Finally, the fieldworker was asked to comment on their opinion of the respondent's food diary. The diary was rated on a scale of 1 to 4: 1, accurate and complete; 2, inaccurate and complete; 3, accurate and incomplete; or 4, inaccurate and incomplete. More exact methods of validation will be carried out in the future which will use cut-off points based on BMR to identify over- and under-reporting.

### *Generation of added sugar intakes from raw data*

In the NSIFCS, NCFS and the NTFCS, sixty-eight food groups were formed. These food groups were used to identify and classify whether they contained purely natural or added sugars or a combination of both of these sugars. To determine the amount of added sugar in recipes, the McCance and Widdowson's recipe database and the recipe database compiled by IUNA were used. Other sources of information used were manufacturer's information and the McCance and Widdowson's food tables<sup>(13,14)</sup> and supplemental volumes<sup>(15–23)</sup>. The actual amounts (in g) of added sugar in the food were calculated using the recipes and food tables which were divided by the total sugar content to calculate the percentage contribution of added sugar to total sugar. The percentage values were transferred directly into the NSIFCS, NCFS and NTFCS databases to compute an actual amount (in g) of added sugar for each food. If a food was not found in any food tables or a recipe was unavailable, the most comparable food or dish was selected.

### *Under-reporting of food intake in the North/South Ireland Food Consumption Survey*

As with any dietary survey where food intake is self-reported there is evidence of mis-reporting, in particular under-reporting, as was found in the NSIFCS<sup>(24)</sup>. Under-reporting can affect

the validity of the results. The analysis in the present study was carried out excluding under-reporters of energy intake, identified as having an energy intake:BMR ratio of less than 1.05<sup>(25)</sup>. Under-reporters were not assessed for children and teenagers.

*Quartiles of added sugar eating occasions per day*

The number of meals consumed per d by subjects from the NSIFCS ranged from one to twenty-two meals per d and from one to twelve meals per d for the NCFS and the NTFS. Further analysis was conducted to determine if there was a significant difference in the results if adults consuming more than nine meals per d (98.7% of the meal frequencies in the database) were excluded from the database. However, there was no significant difference in the results and therefore all meals (one to twenty-two) were included in the analysis. After the exclusion of under-reporters in the NSIFCS, the final sample contained 1097 subjects and quartiles of added sugar eating occasions were determined using these subjects. Quartiles of added sugar eating occasions in children and teenagers were also created using all meals (one to twelve).

*Statistical analysis*

All statistical analyses were carried out using SPSS® version 12.0 for Windows™ (SPSS Inc., Chicago, IL, USA). The Zpopulation samples were divided into quartiles of added

sugar eating occasions. One-way ANOVA was used to test for significant differences ( $P < 0.05$ ) in means for total energy (MJ/d), total and added sugars (g/d and % food energy), added sugar eating occasions, food groups intakes (g/d) and percentage contribution of food groups to added sugar intakes between the quartiles of mean daily added sugar eating occasions. One-way ANOVA was also used to test for significant differences ( $P < 0.05$ ) in means for percentage total energy from fat, carbohydrate, total and added sugar across quartiles of percentage total energy from total fat. Equality of variance was assessed using Levene's test, which determined which *post hoc* test was used. For groups of equal variance, the Scheffe *post hoc* test was used to determine significant differences between the means for each quartile. For values that did not comply with Levene's test for homogeneity of variance, the Tamhane *post hoc* multiple-comparisons test was used to identify significant differences between the means<sup>(26)</sup>.

**Results**

In Table 1, mean daily added sugar eating occasions and mean daily intake of energy (MJ/d), total and added sugar (g/d and % energy) in children, teenagers and adults across quartiles of mean daily added sugar eating occasions are presented. In children, teenagers and adults, added sugar eating occasions significantly increased ( $P < 0.001$ ) across the quartiles of mean daily added sugar eating occasions. In adults, added

**Table 1.** Mean daily eating occasions and mean daily intake of energy (MJ/d), total and added sugar (g/d and % total energy) across quartiles of mean daily added sugar eating occasions in Irish children, teenagers and adults (Mean values and standard deviations)

	Quartiles of mean daily added sugar eating occasions										Significance
	Total		Quartile 1		Quartile 2		Quartile 3		Quartile 4		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Subjects (n)											
Children	594		154		146		149		145		–
Teenagers	441		108		115		102		116		–
Adults	1097		267		265		292		273		–
Added sugar eating occasions											
Children	4.2	0.9	3.1 <sup>a</sup>	0.3	3.9 <sup>b</sup>	0.2	4.4 <sup>c</sup>	0.2	5.3 <sup>d</sup>	0.6	***
Teenagers	3.7	0.9	2.5 <sup>a</sup>	0.4	3.3 <sup>b</sup>	0.2	3.9 <sup>c</sup>	0.2	4.8 <sup>d</sup>	0.5	***
Adults	4.2	1.1	2.9 <sup>a</sup>	0.4	3.7 <sup>b</sup>	0.2	4.4 <sup>c</sup>	0.2	5.6 <sup>d</sup>	0.9	***
Total energy (MJ/d)											
Children	7.0	1.5	6.2 <sup>a</sup>	1.4	7.3 <sup>b</sup>	1.5	7.3 <sup>b</sup>	1.5	7.4 <sup>b</sup>	1.3	***
Teenagers	8.3	2.4	6.7 <sup>a</sup>	1.8	7.9 <sup>b</sup>	2.2	8.6 <sup>b</sup>	2.1	10.0 <sup>c</sup>	2.3	***
Adults	10.2	2.8	9.3 <sup>a</sup>	2.5	9.7 <sup>a</sup>	2.6	10.4 <sup>b</sup>	2.8	11.2 <sup>c</sup>	2.9	*
Total sugar (g/d)											
Children	106.6	34.0	86.4 <sup>a</sup>	27.1	109.9 <sup>b</sup>	34.2	110.8 <sup>c</sup>	30.5	120.9 <sup>c</sup>	34.4	*
Teenagers	108.5	43.0	79.1 <sup>a</sup>	31.2	101.9 <sup>b</sup>	37.9	113.3 <sup>b</sup>	36.8	138.1 <sup>c</sup>	42.4	***
Adults	108.3	44.8	85.6 <sup>a</sup>	30.8	99.7 <sup>b</sup>	38.4	114.5 <sup>c</sup>	44.6	132.3 <sup>d</sup>	49.0	***
Added sugar (g/d)											
Children	65.2	29.7	52.7 <sup>a</sup>	26.7	64.0 <sup>a</sup>	29.2	68.4 <sup>b</sup>	27.7	76.4 <sup>b</sup>	30.5	**
Teenagers	65.7	31.6	47.3 <sup>a</sup>	26.6	61.6 <sup>b</sup>	27.6	70.7 <sup>b</sup>	28.5	82.3 <sup>c</sup>	32.4	**
Adults	61.9	37.7	41.8 <sup>a</sup>	24.9	53.9 <sup>b</sup>	30.1	66.3 <sup>c</sup>	37.2	84.4 <sup>d</sup>	42.0	***
Total energy added sugar (%)											
Children	14.6	5.4	13.5 <sup>a</sup>	6.0	14.0 <sup>a</sup>	5.0	14.8 <sup>a,b</sup>	4.7	16.2 <sup>b</sup>	5.5	**
Teenagers	12.4	4.9	11.0 <sup>a</sup>	5.3	12.4 <sup>a,b</sup>	4.8	13.1 <sup>b</sup>	4.6	13.2 <sup>b</sup>	4.8	*
Adults	9.4	4.3	7.1 <sup>a</sup>	3.7	8.6 <sup>b</sup>	3.6	9.9 <sup>c</sup>	4.1	11.8 <sup>d</sup>	4.2	**
Total energy total sugar (%)											
Children	23.9	5.3	22.1 <sup>a</sup>	5.6	23.8 <sup>b</sup>	5.1	24.1 <sup>b,c</sup>	4.4	25.7 <sup>c</sup>	5.4	*
Teenagers	20.4	5.0	18.6 <sup>a</sup>	5.6	20.2 <sup>a,b</sup>	4.5	20.8 <sup>b,c</sup>	4.5	21.9 <sup>c</sup>	4.7	*
Adults	16.8	4.8	14.6 <sup>a</sup>	4.2	16.3 <sup>b</sup>	4.7	17.5 <sup>c</sup>	4.9	18.7 <sup>c</sup>	4.5	*

<sup>a,b,c,d</sup> Mean values within a row with unlike superscript letters were significantly different: \* $P < 0.05$ ; \*\* $P < 0.01$ ; \*\*\* $P < 0.001$ .

sugar (% energy,  $P < 0.01$  and g/d,  $P < 0.001$ ) and total sugar intakes (% energy,  $P < 0.05$  and g/d,  $P < 0.001$ ) significantly increased across the quartiles and energy intake (MJ/d) was significantly higher ( $P < 0.05$ ) in the 3rd and 4th quartiles in comparison with quartiles 1 and 2. In children and teenagers, total energy (MJ/d) ( $P < 0.001$ ), total sugar (g/d,  $P < 0.05$  children,  $P < 0.001$  teenagers; % energy,  $P < 0.05$ ) and added sugar (g/d,  $P < 0.01$ ; % energy,  $P < 0.01$  children,  $P < 0.05$  teenagers) intakes were significantly higher in the higher quartiles compared with the lower quartiles of mean daily added sugar eating occasions.

Fig. 1 shows the graph of percentage total energy from added sugar *v.* quartiles of added sugar eating occasions in children, teenagers and adults. This highlights how children obtained the highest percentage total energy from added sugar at each quartile of mean daily added sugar occasions. In addition it clearly shows that mean percentage total energy intakes of added sugar was above the recommendation ( $\leq 10\%$ ) in each quartile in children and teenagers.

Table 2 presents the percentage energy intake from fat, carbohydrate, and total and added sugar across quartiles of percentage total energy intake from fat in Irish children, teenagers and adults. There was a significant decrease in percentage energy from carbohydrate ( $P < 0.01$  adults,  $P < 0.001$  children and teenagers) across increasing quartiles of percentage energy from fat in children, teenagers and adults. Intakes of total sugar (% energy) were significantly lower ( $P < 0.01$ ) in quartile 4 compared with all other quartiles in children, teenagers and adults. In adults, added sugar intake (% energy) was significantly ( $P < 0.05$ ) lower in quartile 4 compared with the other quartiles while in children, intakes of added sugar (% energy) were significantly lower ( $P < 0.05$ ) in quartiles 3 and 4 compared with quartiles 1 and 2. In teenagers, intakes of added sugar (% energy) were significantly lower ( $P < 0.01$ ) in quartile 4 compared with quartiles 1 and 2.

Table 3 presents the mean intake (g/d) and percentage contribution of the main food groups to mean daily added sugar intakes across quartiles of mean daily added sugar eating occasions in all Irish children, teenagers and adults. In adults, the main contributors to added sugars intakes were sugars,

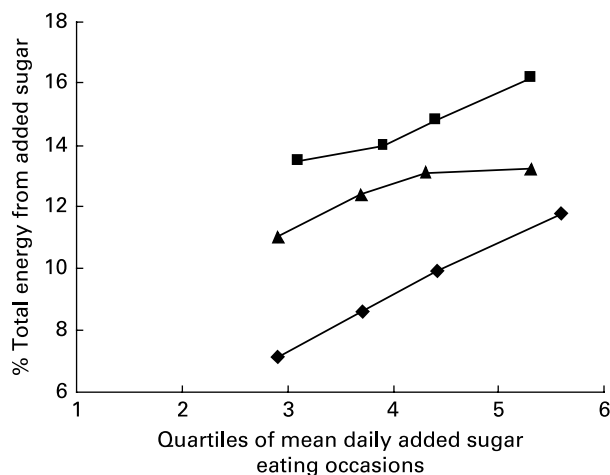


Fig. 1. Relationship between the mean values for percentage total energy from added sugar and the quartiles of added sugar intake in Irish children (■), teenagers (▲) and adults (◆).

syrops, preserves and sweeteners (22.9%), biscuits, cakes, buns and pastries (15.6%), carbonated beverages, squashes and cordials (14.2%) and confectionery (12.2%). The percentage contribution of sugars, syrups, preserves and sweeteners ( $P < 0.01$ ) was significantly higher in the highest quartile compared with the other quartiles. Intakes of all food groups examined, excluding alcohol, breads, RTEBC and carbonated beverages, squashes and cordials (including the individual food groups squashes and cordial and carbonated beverages) were significantly higher in the highest quartile compared with the lowest quartile of mean daily added sugar intake in adults. In children and teenagers, the main contributors to added sugar intakes were carbonated beverages, squashes and cordials (27.7%), confectionery (21.6% children, 22% teenagers), biscuits, cakes, buns and pastries (11.8% children, 9.9% teenagers) and RTEBC (11.1% children, 10.6% teenagers). The percentage contribution of several food groups, for example confectionery ( $P < 0.05$ ) was significantly higher in the highest quartiles compared with the lowest quartiles of mean daily added sugar intake. In addition, there was a significantly higher intake of several food groups such as breads and scones ( $P < 0.01$ ), confectionery, ice cream, pudding and chilled desserts and biscuits, cakes, buns and pastries ( $P < 0.05$  children,  $P < 0.01$  teenagers) in quartile 4 compared with quartile 1 in children and teenagers.

In Table 4 mean daily intakes and percentage contribution of the main food groups to mean daily added sugar intakes are shown across mean daily added sugar eating occasions in Irish children, teenagers and adults in consumers only. The main food groups contributing to added sugar intakes were sugars, syrups, preserves and sweeteners (13.6% teenagers, 27.7% adults), carbonated beverages, squashes and cordials (29.3% children, 31.2% teenagers, 21.4% adults), biscuits, cakes buns and pastries (12.4% children, 12% teenagers, 17.6% adults) and confectionery (23.3% children, 23.9% teenagers, 16.7% adults) and RTEBC (12% children, 13% teenagers). The intake and percentage contribution of several food groups varied across the quartiles of added sugar eating occasions in children, teenagers and adults; for example, the intake of RTEBC was significantly higher and their percentage contribution to added sugar intakes was significantly lower ( $P < 0.05$ ) in quartile 4 compared with quartile 1 in teenagers.

## Discussion

The present paper analysed the frequency of consumption of added sugars in Irish children, teenagers and adults to determine if there is a quantitative relationship between 10% total energy from added sugars and frequency (four times per d) of added sugar intake. An exhaustive search of the literature failed to reveal studies directly relating the association between variability in the frequency of intake of added sugars and the percentage energy from sugars. The present study clearly shows that while the pattern of percentage energy from added sugars varies considerably across age groups, the frequency of added sugar intake varies much less. Thus in general terms it is correct to say that as the frequency of eating occasions of added sugar intakes increases, the percentage energy from added sugar intakes increases. However, there are marked differences in the overall levels

**Table 2.** Percentage total energy from fat, carbohydrates, and total and added sugars across quartiles of percentage total energy from fat in Irish children, teenagers and adults  
(Mean values and standard deviations)

	Quartiles of percentage total energy from fat								Significance
	Quartile 1		Quartile 2		Quartile 3		Quartile 4		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Subjects (n)									
Children	148		148		150		148		–
Teenagers	110		110		111		110		–
Adults	273		275		275		274		–
Total energy fat (%)									
Children	28.6 <sup>a</sup>	2.3	32.5 <sup>b</sup>	0.9	35.2 <sup>c</sup>	0.9	39.3 <sup>d</sup>	2.1	***
Teenagers	29.3 <sup>a</sup>	2.9	34.0 <sup>b</sup>	1.0	37.1 <sup>c</sup>	1.0	41.9 <sup>d</sup>	2.6	***
Adults	28.8 <sup>a</sup>	3.3	34.4 <sup>b</sup>	1.2	37.8 <sup>c</sup>	1.3	35.8 <sup>d</sup>	5.4	***
Total energy carbohydrates (%)									
Children	57.4 <sup>a</sup>	3.5	53.4 <sup>b</sup>	2.5	50.5 <sup>c</sup>	2.2	46.7 <sup>d</sup>	2.8	***
Teenagers	54.3 <sup>a</sup>	4.0	50.8 <sup>b</sup>	2.6	47.6 <sup>c</sup>	2.5	43.3 <sup>d</sup>	3.2	***
Adults	47.5 <sup>a</sup>	7.6	44.8 <sup>b</sup>	5.8	43.3 <sup>c</sup>	4.9	40.3 <sup>d</sup>	4.1	**
Total energy total sugar (%)									
Children	26.8 <sup>a</sup>	5.9	24.5 <sup>a</sup>	5.1	23.2 <sup>b</sup>	4.1	21.1 <sup>c</sup>	4.2	**
Teenagers	23.2 <sup>a</sup>	5.1	21.1 <sup>b</sup>	4.3	20.1 <sup>b</sup>	4.3	17.2 <sup>c</sup>	4.2	**
Adults	18.6 <sup>a</sup>	5.3	17.1 <sup>b</sup>	4.8	16.6 <sup>b</sup>	4.3	14.9 <sup>c</sup>	4.1	**
Total energy added sugar (%)									
Children	16.4 <sup>a</sup>	6.4	15.3 <sup>a</sup>	5.2	13.6 <sup>b</sup>	4.6	12.9 <sup>b</sup>	4.6	*
Children	13.3 <sup>a</sup>	5.5	13.3 <sup>a</sup>	4.9	12.2 <sup>ab</sup>	4.1	10.9 <sup>b</sup>	4.4b	**
Teenagers	9.6 <sup>a</sup>	4.7	9.6 <sup>a</sup>	4.6	9.8 <sup>a</sup>	4.0	8.5 <sup>b</sup>	4.0	*
Adults	28.6 <sup>a</sup>	2.3	32.5 <sup>b</sup>	0.9	35.2 <sup>c</sup>	0.9	39.3 <sup>d</sup>	2.1	***

a,b,c,d Mean values within a row with unlike superscript letters were significantly different: \* $P < 0.05$ ; \*\* $P < 0.01$ ; \*\*\* $P < 0.001$ .

of percentage energy from added sugars in the three age groups. Moreover, there are marked differences in the foods contributing to added sugar intake across age groups.

The results of our analysis highlight how the intake of added sugar varies depending on the age and population group examined. In their report on dietary sugars and human disease, the UK Department of Health noted that children derived a higher proportion of their energy intakes from sugars than adults<sup>(27)</sup>. Although mean percentage energy intake from added sugar in the present study was below the WHO recommended guideline of  $\leq 10\%$  total energy in adults (9%), the mean percentage energy intake from added sugars exceeded the guideline in children (14.6%) and teenagers (12.4%). In addition, mean intake of added sugars in absolute terms in children, teenagers and adults was above 40–55 g/d, the intake below which studies have shown a low incidence of dental caries in countries<sup>(2)</sup>. Although mean added sugar eating occasions (4.2 children, 3.7 teenagers and 4.2 adults) and added sugar intakes were similar in children, teenagers and adults, energy intake (MJ/d) was lower in children (7 MJ/d) and teenagers (8.3 MJ/d) in comparison with adults (10.2 MJ/d). As a result, children and teenagers obtained a higher percentage energy intake from added sugars than adults.

Numerous studies have examined the intake of added sugars in children<sup>(28–31)</sup>, teenagers<sup>(32–34)</sup> and adults<sup>(35)</sup>. However, results from these studies vary on the age, sex, population group and type of sugar analysed, for example, total sugar, NMES and added sugar. As a result, comparisons between surveys can be difficult. Charlton *et al.*<sup>(35)</sup> reported that added sugar intake in adults (aged  $\geq 65$  years) living in South Africa was 17.5% while in Britain, NMES intake in men and women (aged 19–64 years) has been reported to be 13.6 and 11.9% respectively<sup>(36)</sup>. It should be noted that NMES include fruit

juices and honey and ‘added sugar’ which comprise recipe and table sugars<sup>(27)</sup> while the US Department of Agriculture defined added sugars as sugars and syrups that are added to foods during processing or preparation<sup>(37)</sup>.

Added sugar intakes in the NCFS (14.6%) were similar to those reported by Farris *et al.*<sup>(29)</sup> who showed that added sugar intakes (% energy) in American children (aged 10 years) was 15.2%. In addition, Munoz *et al.*<sup>(32)</sup> reported that mean daily added sugars intake in American children and adolescents (aged 2–19 years) was 15.9%. Kranz *et al.*<sup>(31)</sup> reported that added sugar intakes in American children (aged 2–5 years) was 14.9% in 2–3-year-olds and 16.5% in 4–5-year-olds. However, intakes vary widely in studies. Somerset<sup>(34)</sup> reported that refined sugar intakes in Australian children and adolescents aged 2–18 years ranged from 26.9 to 78.3 g/d (6.6–14.8% total energy) for girls and from 27 to 81.6 g/d (8–14% total energy) for boys. Kersting *et al.*<sup>(33)</sup> reported that mean energy intake from added sugars in German children and adolescents aged 1–18 years was 12%. In Norwegian studies, added sugar intakes have been reported at 15.1% energy (55 g/d) in 4-year-olds<sup>(30)</sup>, 16.8% (80 g/d) energy in 9-year-olds<sup>(30)</sup> and at 11%<sup>(28)</sup> and 18.4% (95 g/d)<sup>(30)</sup> in 13-year-olds.

Mean daily total sugar intake in children (106.6 g/d; 23.9%) in the present study was lower than that reported by Gibson<sup>(38)</sup> (123 g/d; 23%), Morgan & Zabik<sup>(39)</sup> (134 g/d), Hackett *et al.*<sup>(40)</sup> (boys 124 g/d; girls 113 g/d), Burt *et al.*<sup>(41)</sup> (boys 156 g/d; girls 127 g/d) and Strain *et al.*<sup>(42)</sup> (139 g/d boys; 121 g/d girls; aged 12 years) but higher than the total sugar (% energy) intake reported by Farris *et al.*<sup>(29)</sup> (15.2%). The variation in added and total sugar intakes between studies clearly shows that research analysing sugar intakes is needed in each individual country before sugar recommendations should be established to determine if sugar intakes

**Table 3.** Intake (g/d) and contribution (%) of the main food groups to mean daily added sugar intakes across quartiles of mean daily added sugar eating occasions in Irish children, teenagers and adults in all consumers  
(Mean values and standard deviations)

(g/d)	Quartiles of mean daily added sugar eating occasions															P <sub>wt</sub>	P <sub>%</sub>
	Total			Quartile 1			Quartile 2			Quartile 3			Quartile 4				
	Mean	SD	% contr	Mean	SD	% contr	Mean	SD	% contr	Mean	SD	% contr	Mean	SD	% contr		
<b>Subjects (n)</b>																	
Children		594		154			146			149			145			–	–
Teenagers		441		108			115			102			116			–	–
Adults		1097		267			265			292			273			–	–
<b>Sugars, syrups, preserves and sweeteners</b>																	
Children	6	11	7.3	5	8	7.9	8	17	8.7	6	7	6.6	6	7	6.1	NS	NS
Teenagers	8	12	8.7	6	10	8.6	7	12	7.4	10	15	10.1	9	12	9.0	NS	NS
Adults	21	24	22.9	12 <sup>w</sup>	16	19.0 <sup>a</sup>	16 <sup>w</sup>	20	20.1 <sup>a</sup>	21 <sup>x</sup>	23	22.5 <sup>a</sup>	33 <sup>y</sup>	31	30.0 <sup>b</sup>	*	**
<b>Biscuits, cakes, buns and pastries</b>																	
Children	25	19	11.8	18 <sup>w</sup>	15	10.8	24 <sup>x</sup>	18	10.9	29 <sup>x,y</sup>	20	13.0	31 <sup>y</sup>	21	12.4	*	NS
Teenagers	24	30	9.9	14 <sup>w</sup>	19	9.0 <sup>a,b</sup>	18 <sup>w,x</sup>	24	8.2 <sup>a</sup>	26 <sup>x,y</sup>	28	10.0 <sup>a,b</sup>	37 <sup>y</sup>	38	12.3 <sup>b</sup>	**	*
Adults	36	34	15.6	22 <sup>w</sup>	27	13.6	31 <sup>x</sup>	28	15.8	41 <sup>y</sup>	36	16.8	49 <sup>y</sup>	39	16.1	*	NS
<b>Biscuits</b>																	
Children	15	13	6.7	11 <sup>w</sup>	11	6.1	13 <sup>w,x</sup>	11	6.0	16 <sup>x,y</sup>	14	7.0	19 <sup>y</sup>	14	7.8	**	NS
Teenagers	12	17	5.2	8 <sup>w</sup>	13	5.4 <sup>a,b</sup>	8 <sup>w</sup>	14	3.5 <sup>a</sup>	12 <sup>w</sup>	13	5.3 <sup>a,b</sup>	19 <sup>x</sup>	22	6.5 <sup>b</sup>	*	**
Adults	16	19	11.3	9 <sup>w</sup>	16	18.4 <sup>a</sup>	13 <sup>w</sup>	16	11.3 <sup>b</sup>	19 <sup>x</sup>	19	9.0 <sup>b,c</sup>	23 <sup>y</sup>	20	6.8 <sup>c</sup>	**	*
<b>Cakes, buns and pastries</b>																	
Children	11	14	5.1	7 <sup>w</sup>	10	4.6	10 <sup>w,x</sup>	14	4.9	13 <sup>x</sup>	15	6.1	12 <sup>x</sup>	15	4.7	*	NS
Teenagers	12	22	4.7	5 <sup>w</sup>	13	3.5	10 <sup>w,x</sup>	17	4.7	14 <sup>x,y</sup>	24	4.7	18 <sup>y</sup>	29	5.8	*	NS
Adults	20	26	8.0	13 <sup>w</sup>	20	7.0	18 <sup>w,x</sup>	22	8.4	19 <sup>x,y</sup>	19	8.7	23 <sup>y</sup>	20	8.0	**	NS
<b>Carbonated beverages, squashes and cordials</b>																	
Children	195	167	27.7	167 <sup>w</sup>	154	29.6	179 <sup>w</sup>	162	27.3	193 <sup>w,x</sup>	144	27.1	241 <sup>x</sup>	197	26.8	*	NS
Teenagers	219	199	27.7	191	190	30.9 <sup>a</sup>	236	208	30.4 <sup>a</sup>	238	199	29.2 <sup>a</sup>	211	199	20.7 <sup>b</sup>	NS	**
Adults	120	180	14.2	100	158	15.5 <sup>a</sup>	119	187	15.8 <sup>a</sup>	128	183	14.5 <sup>a</sup>	130	191	11.0 <sup>b</sup>	NS	*
<b>Carbonated beverages</b>																	
Children	122	136	15.6	108	133	16.5	117	140	15.2	132	131	16.6	132	140	14.0	NS	NS
Teenagers	185	189	22.0	175	189	27.2 <sup>a</sup>	208	206	25.3 <sup>a</sup>	202	189	23.9 <sup>a</sup>	156	169	14.2 <sup>b</sup>	NS	***
Adults	96	162	11.7	82	149	13.0	94	164	12.6	104	162	12.1	103	171	9.3	NS	NS
<b>Squashes and cordials</b>																	
Children	72	93	12.1	59 <sup>w</sup>	71	13.1	62 <sup>w</sup>	70	12.1	61 <sup>w</sup>	58	10.5	109 <sup>x</sup>	142	12.7	***	NS
Teenagers	34	66	5.2	16 <sup>w</sup>	35	3.7	28 <sup>w,x</sup>	50	5.1	36 <sup>x,y</sup>	61	5.3	55 <sup>y</sup>	93	6.5	*	NS
Adults	24	73	2.4	18	54	2.6	25	76	3.2	24	74	2.4	28	85	1.6	NS	NS
<b>Confectionery</b>																	
Children	28	23	21.6	20 <sup>w</sup>	18	19.1 <sup>a</sup>	24 <sup>w</sup>	20	19.4 <sup>a</sup>	31 <sup>x</sup>	24	23.5 <sup>a,b</sup>	36 <sup>x</sup>	25	24.6 <sup>b</sup>	*	***
Teenagers	32	29	22.0	18 <sup>w</sup>	18	18.6 <sup>a</sup>	28 <sup>x</sup>	23	20.4 <sup>a</sup>	35 <sup>x,y</sup>	31	22.3 <sup>a,b</sup>	46 <sup>y</sup>	34	27.8 <sup>b</sup>	**	*
Adults	15	24	12.2	10 <sup>w</sup>	14	11.2	12 <sup>w</sup>	17	11.3	17 <sup>x</sup>	21	12.7	23 <sup>x</sup>	35	13.5	**	NS
<b>Chocolate confectionery</b>																	
Children	17	17	12.8	13 <sup>w</sup>	14	11.6	16 <sup>w,x</sup>	16	12.3	18 <sup>x,y</sup>	16	12.7	23 <sup>y</sup>	20	14.8	**	NS
Teenagers	21	20	14.9	12 <sup>w</sup>	15	13.0 <sup>a,b</sup>	16 <sup>w</sup>	16	12.4 <sup>a</sup>	24 <sup>x</sup>	20	16.6 <sup>b</sup>	30 <sup>x</sup>	24	17.8 <sup>b</sup>	**	*
Adults	13	22	10.3	9 <sup>w</sup>	14	9.8	10 <sup>w</sup>	16	9.1	15 <sup>x</sup>	19	10.8	20 <sup>x</sup>	33	11.6	**	NS
<b>Non-chocolate confectionery</b>																	
Children	11	13	8.8	8 <sup>w</sup>	10	7.5 <sup>a</sup>	8 <sup>w</sup>	9	7.1 <sup>a,b</sup>	13 <sup>w,x</sup>	16	10.8 <sup>c</sup>	14.0 <sup>x</sup>	14	9.9 <sup>a,c</sup>	**	*
Teenagers	11	18	7.3	6 <sup>w</sup>	10	5.6 <sup>a</sup>	11 <sup>x</sup>	19	8.1 <sup>a,b</sup>	11 <sup>w,x</sup>	19	5.7 <sup>a,b</sup>	16 <sup>x</sup>	19	9.7 <sup>b</sup>	*	*
Adults	2	5	1.9	1 <sup>w</sup>	3	1.5	2 <sup>w,x</sup>	5	2.2	2 <sup>x</sup>	6	1.9	3 <sup>x</sup>	6	1.9	**	NS

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Table 3. Continued

(g/d)	Quartiles of mean daily added sugar eating occasions																
	Total			Quartile 1			Quartile 2			Quartile 3			Quartile 4				
	Mean	SD	% contr	Mean	SD	% contr	Mean	SD	% contr	Mean	SD	% contr	Mean	SD	% contr	P <sub>wt</sub>	P <sub>%</sub>
Breads, scones, etc	82	39	4.6	72 <sup>w,y</sup>	37	5.3 <sup>a</sup>	88 <sup>x,y</sup>	44	4.7 <sup>a,b</sup>	86 <sup>x,y</sup>	37	4.4 <sup>a,b</sup>	82 <sup>y</sup>	38	4.0 <sup>b</sup>	**	**
Children	92	55	5.5	66 <sup>w</sup>	40	6.8	86 <sup>x</sup>	42	5.2	103 <sup>x,y</sup>	56	4.9	114 <sup>y</sup>	67	5.1	**	NS
Teenagers	148	78	8.0	138	85	11.0 <sup>a</sup>	144	67	8.4 <sup>b</sup>	153	81	7.0 <sup>b,c</sup>	155	76	5.8 <sup>c</sup>	**	**
Adults																NS	**
RTEBC	31	24	11.1	27 <sup>w</sup>	24	11.4	35 <sup>x</sup>	24	12.3	31 <sup>w,x</sup>	24	10.2	31 <sup>w,x</sup>	24	10.3	*	NS
Children	31	32	10.6	22 <sup>w</sup>	24	11.4	32 <sup>w,x</sup>	33	12.6	29 <sup>w,x</sup>	30	9.1	38 <sup>x</sup>	38	9	**	NS
Teenagers	21	24	5.5	18	22	6.8 <sup>a</sup>	21	26	6.0 <sup>a</sup>	22	26	5.2 <sup>a,b</sup>	22	24	4.1 <sup>b</sup>	NS	*
Adults	384	635	6.4	367	600	6.5	358	559	5.6	350	573	5.7	462	779	7.8	NS	NS
Ice cream, pudding and chilled desserts																	
Children	23	27	5.8	18 <sup>w</sup>	31	5.5	22 <sup>w,x</sup>	21	5.9	24 <sup>w,x</sup>	26	5.7	28 <sup>x</sup>	30	6.1	*	NS
Teenagers	20	30	5.0	13 <sup>w</sup>	24	4.6	16 <sup>w,x</sup>	30	4.3	23 <sup>w,x</sup>	32	5.2	27 <sup>x</sup>	31	5.8	**	NS
Adults	32	41	7.9	22 <sup>w</sup>	28	8.2	32 <sup>x</sup>	40	8.3	37 <sup>x</sup>	39	8.6	38 <sup>x</sup>	51	6.5	*	NS

% contr, % Contribution of food groups to added sugar intakes; RTEBC, ready-to-eat breakfast cereal.  
<sup>a,b,c</sup> Values with unlike superscript letters denote significant differences in mean percentage contributions of food groups to added sugar intakes between quartiles of added sugar eating occasions (P<sub>wt</sub>): \* P<0.05; \*\* P<0.01; \*\*\* P<0.001; NS, P≥0.05.  
<sup>w,x,y,z</sup> Values with unlike superscript letters denote significant differences in mean intake of food groups between quartiles of mean daily added sugar eating occasions (P<sub>%</sub>): \* P<0.05; \*\* P<0.01; \*\*\* P<0.001; NS, P≥0.05.

are acceptable or excessively high. Furthermore, a standardised definition and method of determining added sugar intakes may help reduce the variation in added sugar intakes in future studies.

Numerous studies have shown an inverse relationship between fat and sugar intakes where, in general, as sugar intakes (total, added or NMES) increase, fat intakes decrease<sup>(29,31,35,38,43-48)</sup>. There is concern that if individuals are advised to limit foods high in added sugars they may increase their intake of foods high in fat<sup>(44)</sup> and that dietary goals advising a simultaneous reduction in fat and sugar may not be achievable<sup>(38)</sup>. We found that as the intake of fat increased (% energy) in children (28.6 to 39.3%), teenagers (29.3 to 41.9%) and adults (28.8 to 35.8%), there was a significant decrease (P<0.05) in total and added sugar intakes. Studies would be required to assess how both these recommendations can be simultaneously achieved.

In general, the main sources and contributors to added sugars have been shown to be soft drinks, confectionery, cakes, biscuits and ice cream<sup>(30,31,37,48)</sup>. However, the main contributors to sugar intake vary depending on the age, sex and population group studied. For example, one of the main contributors to added sugar intake in children are non-diet soft drinks<sup>(29,30,34,39,49,50)</sup>, the percentage contribution of which has been shown to decrease with age<sup>(51)</sup>.

The present results showed that the main contributors to mean daily added sugar differed for children, teenagers and adults. In addition, the percentage contribution and intake of the main contributors to mean daily added sugar intake were significantly different across the quartiles of mean daily added sugar eating occasions in children, teenagers and adults. The main contributors to added sugar intake in all children, teenagers and adults were biscuits, cakes, buns and pastries, carbonated beverages, squashes and cordials, confectionery, sugars, syrups, preserves and sweeteners (adults only) and RTEBC (children and teenagers). It may therefore be important to target these food groups to help reduce added sugar intakes, especially in children and teenagers.

There are concerns that high intake of added sugars may dilute micronutrients, displace nutrient-dense foods<sup>(52)</sup> and that sugar-sweetened beverages may be a contributor to the rise in overweight and obesity<sup>(53)</sup>. These issues were not addressed in the present study as the recommendation limiting the intake of food and beverages containing added sugars to a maximum intake of four meals per d was developed by the WHO<sup>(2)</sup> to help prevent against dental caries. In the present study, 7 d food diaries were used to collect dietary information. Therefore changes in the frequency of consumption of foods and beverages containing added sugar is more likely to be accounted for across the week using this data collection method in comparison with data collection methods of shorter duration.

Information on under-reporting was available for the NSIFCS and under-reporters were excluded in the present study as there is evidence to suggest that in adults, low energy reporters tend to report foods such as cakes, cookies, sugar and candies less often compared with non-low energy reporters<sup>(54)</sup>. In the UK National Diet and Nutrition Study of young people aged 4–18 years, Gregory *et al.*<sup>(55)</sup> reported that those classified as under-reporters tended to selectively under-report foods that were high in NMES. It would be an advantage to account for under-reporting in children and teenagers to determine if this

**Table 4.** Intake (g/d) and contribution (%) of the main food groups to mean daily added sugar intakes across quartiles of mean daily added sugar eating occasions in Irish children, teenagers and adults in consumers only

(Mean values and standard deviations)

	Quartiles of mean daily added sugar eating occasions																				P <sub>wt</sub>	P <sub>%</sub>	
	Total				Quartile 1				Quartile 2				Quartile 3				Quartile 4						
	% Cons	Mean	SD	% contr	% Cons	Mean	SD	% contr	% Cons	Mean	SD	% contr	% Cons	Mean	SD	% contr	% Cons	Mean	SD	% contr			
<b>Sugars, syrups, preserves and sweeteners</b>																							
Children	78	8	11	9.5	25	7	9	10.7	25	10	18	10.9	26	7	7	8.3	24	7	7	7.9	NS	NS	
Teenagers	65	12	14	13.6	23	10	12	15.6	26	11	14	12.1	23	13	16	13.4	27	13	12	12.7	NS	NS	
Adults	83	25	25	27.7	24	16 <sup>w</sup>	16	25.4 <sup>a</sup>	25	21 <sup>w,x</sup>	20	25.5 <sup>a</sup>	25	25 <sup>x</sup>	24	26.6 <sup>a</sup>	25	37 <sup>y</sup>	32	33.0 <sup>b</sup>	***	*	
<b>Biscuits, cakes, buns and pastries</b>																							
Children	95	27	19	12.4	24	21 <sup>w</sup>	14	12.0	24	26 <sup>x</sup>	18	11.8	26	30 <sup>x</sup>	20	13.3	25	31 <sup>x</sup>	21	12.6	***	NS	
Teenagers	82	29	30	12.0	24	20 <sup>w</sup>	23	12.3	26	24 <sup>w</sup>	25	11.0	25	29 <sup>w,x</sup>	25	11.4	25	41 <sup>x</sup>	40	13.7	**	NS	
Adults	89	40	34	17.6	26	29 <sup>w</sup>	27	17.3	25	37 <sup>x</sup>	31	17.5	22	45 <sup>x,y</sup>	34	18.5	26	52 <sup>y</sup>	38	17.1	**	NS	
<b>Biscuits</b>																							
Children	87	17	12	7.7	25	14 <sup>w</sup>	11	7.7	23	15 <sup>w,x</sup>	11	7.0	26	18 <sup>x,y</sup>	13	7.8	27	20 <sup>x,y</sup>	14	8.2	**	NS	
Teenagers	69	17	18	7.5	24	14 <sup>w</sup>	15	8.8	24	14 <sup>w</sup>	15	6.4	26	16 <sup>w,x</sup>	13	6.5	26	24 <sup>x</sup>	24	8.3	*	NS	
Adults	79	20	19	10.5	24	14 <sup>w</sup>	18	16.8 <sup>a</sup>	25	17 <sup>w</sup>	16	10.0 <sup>b</sup>	26	23 <sup>x</sup>	19	8.8 <sup>b,c</sup>	25	27 <sup>x</sup>	20	6.7 <sup>c</sup>	*	*	
<b>Cakes, buns and pastries</b>																							
Children	60	18	14	8.4	26	15	9	9.1	24	18	15	8.6	23	19	16	8.6	26	19	15	7.3	NS	NS	
Teenagers	48	25	27	9.8	22	22	21	12.4	27	24	24	9.8	24	23	21	9.0	26	28	37	8.3	NS	NS	
Adults	64	31	27	12.5	23	26 <sup>w</sup>	22	14.6 <sup>a</sup>	28	29 <sup>w,x</sup>	25	12.4 <sup>a,b</sup>	24	32 <sup>w,x</sup>	27	12.5 <sup>a,b</sup>	25	35 <sup>x</sup>	32	10.6 <sup>b</sup>	*	**	
<b>Carbonated beverages, squashes and cordials</b>																							
Children	94	206	165	29.3	25	181 <sup>w</sup>	152	32.1	24	194 <sup>w,x</sup>	160	29.5	26	200 <sup>w,x</sup>	142	28.0	25	250 <sup>x</sup>	195	27.7	*	NS	
Teenagers	89	247	195	31.2	26	243	183	38.7 <sup>a</sup>	25	255	201	32.8 <sup>a</sup>	25	260	199	31.3 <sup>a</sup>	24	229	197	21.6 <sup>b</sup>	NS	*	
Adults	66	180	195	21.4	24	171	169	27.1 <sup>a</sup>	26	196	210	24.2 <sup>a,b</sup>	23	173	193	19.8 <sup>b</sup>	27	178	203	15.0 <sup>c</sup>	NS	*	
<b>Carbonated beverages</b>																							
Children	80	154	136	19.6	25	141	136	21.5	24	151	142	19.6	28	159	125	20.0	23	163	143	16.9	NS	NS	
Teenagers	82	225	186	27.4	26	234	182	35.7	25	243	202	29.5	25	236	188	27.2	23	184	165	16.2	NS	*	
Adults	58	165	183	20.2	26	173	185	26.2 <sup>a</sup>	26	169	177	22.2 <sup>a</sup>	23	148	173	17.1 <sup>b</sup>	25	168	199	14.8 <sup>b</sup>	NS	*	
<b>Squashes and cordials</b>																							
Children	78	92	96	15.4	24	81 <sup>w</sup>	72	18.2 <sup>a</sup>	25	79 <sup>w</sup>	70	15.3 <sup>a,b</sup>	26	76 <sup>w</sup>	56	12.9 <sup>b</sup>	25	133 <sup>x</sup>	146	15.5 <sup>b</sup>	**	*	
Teenagers	45	76	80	11.5	25	62 <sup>w,x</sup>	57	12.7	24	52 <sup>w</sup>	53	9.6	24	85 <sup>w,x</sup>	89	10.6	27	103 <sup>x</sup>	99	13.0	**	NS	
Adults	24	100	123	10.3	24	92	90	14.0 <sup>a</sup>	28	108	130	12.2 <sup>a</sup>	26	88	113	8.4 <sup>a,b</sup>	23	111	151	6.3 <sup>b</sup>	NS	*	
<b>Confectionery</b>																							
Children	93	30	22	23.3	24	23 <sup>w</sup>	17	22.0	24	26 <sup>w,x</sup>	19	21.3	26	32 <sup>x,y</sup>	24	24.3	25	38 <sup>y</sup>	24	25.5	**	NS	
Teenagers	93	34	29	23.9	22	21 <sup>w</sup>	18	21.8 <sup>a</sup>	27	29 <sup>w,x</sup>	23	21.2 <sup>a</sup>	25	39 <sup>x,y</sup>	33	24.0 <sup>a,b</sup>	25	48 <sup>y</sup>	32	28.8 <sup>b</sup>	***	*	
Adults	73	21	25	16.7	25	17 <sup>w</sup>	15	18.4	23	19 <sup>w</sup>	26	16.1	28	21 <sup>w,x</sup>	20	16.2	24	28 <sup>x</sup>	39	16.3	*	NS	
<b>Chocolate confectionery</b>																							
Children	84	20	17	15.3	25	17 <sup>w</sup>	14	15.6	21	19 <sup>w,x</sup>	15	15.4	28	20 <sup>w,x</sup>	16	14.3	25	25 <sup>x</sup>	20	16.0	**	NS	
Teenagers	84	25	20	17.8	28	18 <sup>w</sup>	16	17.2	21	19 <sup>w</sup>	15	15.5	28	29 <sup>x</sup>	21	18.4	24	33 <sup>x</sup>	22	20.0	***	*	
Adults	67	20	24	15.4	19	16 <sup>w,x</sup>	15	18.2 <sup>a</sup>	23	16 <sup>w</sup>	17	14.3 <sup>b</sup>	28	21 <sup>x</sup>	19	15.2 <sup>a,b</sup>	29	25 <sup>y</sup>	35	14.7 <sup>a,b</sup>	*	*	
<b>Non-chocolate confectionery</b>																							
Children	76	14	13	11.6	26	11 <sup>w</sup>	10	10.9 <sup>a,b</sup>	24	11 <sup>w</sup>	10	9.9 <sup>a</sup>	22	18 <sup>x</sup>	17	14.0 <sup>b</sup>	27	16 <sup>x</sup>	13	11.7 <sup>a,b</sup>	*	*	
Teenagers	66	17	19	11.8	26	13	14	12.2	23	16	20	13.3	27	18	21	10.7	24	21	20	11.3	NS	NS	
Adults	26	7	8	7.2	25	7	6	9.9 <sup>a</sup>	22	9	10	7.9 <sup>a,b</sup>	28	7	7	5.8 <sup>b</sup>	24	7	9	5.3 <sup>b</sup>	NS	*	
<b>Breads, scones, etc</b>																							
Children	100	82	39	4.6	26	72 <sup>w</sup>	34	5.3 <sup>a</sup>	25	88 <sup>x</sup>	44	4.7 <sup>a,b</sup>	25	86 <sup>x</sup>	37	4.4 <sup>a,b</sup>	24	82 <sup>w,x</sup>	38	4.0 <sup>b</sup>	**	***	
Teenagers	99	93	55	5.5	24	67 <sup>w</sup>	88	6.9	26	88 <sup>w,x</sup>	41	5.3	23	103 <sup>x,y</sup>	56	4.9	26	114 <sup>y</sup>	67	5.1	**	NS	
Adults	99.7	148	77	8.1	27	137	81	10.8 <sup>a</sup>	24	147	68	8.4 <sup>b</sup>	24	155	82	7.0 <sup>c</sup>	25	155	76	5.8 <sup>d</sup>	NS	*	

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Table 4. Continued

	Quartiles of mean daily added sugar eating occasions																				
	Total			Quartile 1			Quartile 2			Quartile 3			Quartile 4								
	% Cons	Mean	SD	% contr	% Cons	Mean	SD	% contr	% Cons	Mean	SD	% contr	% Cons	Mean	SD	% contr	P <sub>wt</sub>	P <sub>%</sub>			
Children	93	33	23	12.0	24	31	23	13.1	25	37	24	12.8	25	33	23	11.0	25	32	23	11.0	NS
Teenagers	81	38	32	13.0	25	31 <sup>w</sup>	23	15.6 <sup>a</sup>	24	40 <sup>w,x</sup>	33	15.3 <sup>a</sup>	27	36 <sup>w,x</sup>	30	11.0 <sup>b</sup>	24	45 <sup>x</sup>	39	10.2 <sup>b</sup>	*
Adults	69	30	24	8.0	24	27	22	10.1 <sup>a</sup>	26	30	25	9.3 <sup>a</sup>	24	31	27	6.7 <sup>b</sup>	25	31	23	5.9 <sup>b</sup>	NS
Alcohol (adults)	69	556	698	9.3	24	544	662	9.6	25	510	606	8.0	27	499	628	8.2	25	678	864	11.4	NS
Ice cream, pudding and chilled desserts	74	31	28	7.8	25	28	35	8.3	24	29	18	7.6	26	32	25	7.5	26	36	29	7.8	NS
Children	62	32	33	8.0	24	26	28	8.8	24	30	35	7.9	26	34	34	7.2	26	38	33	8.3	NS
Teenagers	72	45	42	11.0	24	35 <sup>w</sup>	27	13.0 <sup>a</sup>	24	46 <sup>x</sup>	42	11.9 <sup>a</sup>	27	48 <sup>x</sup>	41	10.6 <sup>a,b</sup>	24	51 <sup>x</sup>	51	8.6 <sup>b</sup>	*

% Cons, % consumers of each food groups; % contr, % contribution of food groups to added sugar intakes; RTEBC, ready-to-eat breakfast cereal.  
<sup>a,b,c</sup> Values with unlike superscript letters denote significant differences in mean percentage contributions of food groups to added sugar intakes between quartiles of mean daily added sugar eating occasions (P<sub>%</sub>); \*P<0.05; \*\*P<0.01; \*\*\*P<0.001; NS, P≥0.05.  
<sup>w,x,y,z</sup> Values with unlike superscript letters denote significant differences in mean intake of food groups between quartiles of mean daily added sugar eating occasions (P<sub>wt</sub>); \*P<0.05; \*\*P<0.01; \*\*\*P<0.001; NS, P≥0.05.

affects the relationship between energy from added sugars and frequency of added sugars intake.

In conclusion, the key findings of the present study are that the frequency of added sugar intake is similar but percentage energy from added sugars varies considerably across the three age groups. Furthermore, sources of added sugar vary with age. Food-based dietary guidelines may need to be tailored to specific age groups.

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