

Package size and manufacturer-recommended serving size of sweet beverages: a cross-sectional study across four high-income countries

Maartje P Poelman^{1,*}, Helen Eyles², Elizabeth Dunford³, Alyssa Schermel⁴, Mary R L'Abbe⁴, Bruce Neal³, Jacob C Seidell¹, Ingrid HM Steenhuis¹ and Cliona Ni Mhurchu²

¹VU University Amsterdam, Department of Health Sciences and EMGO + Institute for Health and Care Research, De Boelelaan 1085, 1081 HV Amsterdam, The Netherlands: ²National Institute for Health Innovation, School of Population Health, The University of Auckland, Auckland, New Zealand: ³The George Institute for Global Health, University of Sydney, Camperdown, New South Wales, Australia: ⁴Department of Nutritional Sciences, University of Toronto, Toronto, Ontario, Canada

Submitted 11 August 2014: Final revision received 6 March 2015: Accepted 14 May 2015: First published online 7 July 2015

Abstract

Objective: To assess the mean package size and manufacturer-recommended serving size of sweet beverages available in four high-income countries: Australia, Canada, the Netherlands and New Zealand.

Design: Cross-sectional surveys.

Setting: The two largest supermarket chains of each country in 2012/2013.

Subjects: Individual pack size (IPS) drinks (*n* 891) and bulk pack size (BPS) drinks (*n* 1904).

Results: For all IPS drinks, the mean package size was larger than the mean serving size (mean (SD) = 412 (157) ml and 359 (159) ml, respectively). The mean (SD) package size of IPS drinks was significantly different for all countries (range: Australia = 370 (149) ml to New Zealand = 484 (191) ml; *P* < 0.01). The mean (SD) package size of Dutch BPS drinks (1313 (323) ml) was significantly smaller compared with the other countries (New Zealand = 1481 (595) ml, Australia = 1542 (595) ml, Canada = 1550 (434) ml; *P* < 0.01). The mean (SD) serving size of BPS drinks was significantly different across all countries (range: Netherlands = 216 (30) ml to Canada = 248 (31) ml; *P* < 0.00). New Zealand had the largest package and serving sizes of the countries assessed. In all countries, a large number of different serving sizes were used to provide information on the amount appropriate to consume in one sitting.

Conclusions: At this point there is substantial inconsistency in package sizes and manufacturer-recommended serving sizes of sweet beverages within and between four high-income countries, especially for IPS drinks. As consumers do factor serving size into their judgements of healthiness of a product, serving size regulations, preferably set by governments and global health organisations, would provide consistency and assist individuals in making healthier food choices.

Keywords

Package size
Serving size
Non-alcoholic beverages
Portion size
Supermarket

The high global prevalence of overweight and obesity over the past three decades parallels increased consumption of sweet beverages, of which sugar-sweetened beverages are of particular concern⁽¹⁾. The consumption of sugar-sweetened beverages is associated with weight gain in children⁽²⁾ and adults^(1,3). Moreover, ingestion of energy in the form of liquids rather than energy-matched solid foods has been shown to increase energy consumption due to the lower satiety provided by liquid foods⁽⁴⁾.

Over the past few years, the package size of sweet beverages has increased⁽⁵⁾ and research indicates that larger packages are positively associated with energy intakes⁽⁶⁾. However, in many high-income countries it is a requirement to provide nutritional information on all packed food and beverage items⁽⁷⁾, including a recommended serving size which reflects 'the recommended amount to consume in one sitting'⁽⁸⁾. In Australia and New Zealand, it is mandatory to display a recommended

*Corresponding author: Email m.p.poelman@uu.nl

serving size as per the Australia New Zealand Food Standards code^(9,10); however, standard serving sizes for food and beverages are not provided⁽⁹⁾. In contrast, regulated food and beverage serving sizes are available for Canada and the USA^(10,11). These recommendations include acceptable ranges in millilitres within which beverage serving sizes must fall. For example, according to the Canadian Food Inspection Agency, the prescribed reference amount for soft drink is 355 ml, with an acceptable range between 250 and 375 ml⁽¹²⁾. If a single serving size container is 150% or less than the reference amount (150% of 355 ml = 532.5 ml) then the quantity may still be termed 'one serving'. However, a container larger than 150% of the reference amount that is intended to be consumed in one sitting may also still be termed 'one serving'⁽¹⁰⁾. This regulation provides manufacturers with flexibility to provide an appropriate serving size recommendation taking into account the energy density and/or package size of the product⁽¹⁰⁾. Moreover, this regulation allows single serving size containers outside the recommended range to be termed 'one serving'.

Although not all governments of high-income countries provide standards or reference serving size amounts for food and beverage items, there are other groups, such as non-government organisations, that do. For example, a recent study regarding serving size guidance in the UK showed a variety in serving size schemes proposed by profit and non-profit organisations⁽⁸⁾. Consequently, there is a wide range of serving sizes displayed on products available for consumers^(13–15) and there may be discrepancies between recommended serving sizes suggested by the non-government organisations, health-care professionals and the food industry⁽¹⁶⁾. A recent study among a large number of European consumers showed that consumers do factor serving size into their judgements of the healthiness of a product. Moreover, the study revealed that when nutritional values for half serving sizes in comparison to single servings or per 100 g/100 ml were presented, these products were judged as healthier⁽¹⁷⁾. New European Union food labelling laws came into effect in December 2014; however, they do not include mandatory or comprehensive regulations regarding serving size labelling. Nevertheless, the new law states that 'in order to provide comparable indications relating to portions or consumption units, the commission should be empowered to adopt rules on the expression of the nutrition declaration per portion or per consumption unit for specific categories of food'⁽¹⁸⁾.

The aim of the present study was to assess the package size and recommended serving size of sweet beverages across four high-income countries. It was hypothesized that there would be a wide range of package and recommended serving sizes available within and between countries, for similar products.

Materials and methods

Participating countries

This research was undertaken within the framework of the Global Food Monitoring Group established in 2011 to systematically monitor and report on the nutritional composition of packaged foods around the world and to bring transparency and objectivity to the monitoring process⁽¹⁹⁾. There are currently thirty-one member countries ranging from low- to high-income in terms of OECD (Organisation for Economic Co-operation and Development) classifications. Four high-income member countries of this group with similar food supplies (Australia, Canada, the Netherlands and New Zealand) were included in the current study. For these four countries, nutrition labelling (including serving size) is provided on the majority of foods and beverages. In Australia, New Zealand⁽⁹⁾ and Canada⁽¹⁰⁾, it is mandatory for packaged products to display the package size and serving size. In the Netherlands it is mandatory for packaged products to display the package size⁽²⁰⁾, although it is voluntary to display the serving size.

Data collection and measures

Cross-sectional surveys were undertaken in two large stores representing the two supermarket chains with the highest market share in each country. Stores were located in the biggest cities of each participating country (Amsterdam, Auckland, Toronto and Sydney). As such, the main drink varieties of each country were represented. Surveys were undertaken in 2012 (Australia; between July and December) and 2013 (Netherlands, New Zealand and Canada; between March and September). Product and serving size data were collected by the research assistants, directly from the Nutrition Information Panels displayed on packages of all sweet beverages for sale in each store⁽²¹⁾. Sweet beverages were defined as those that were sugar- or artificially sweetened and energy content was determined by kJ per 100 ml. Sweet beverages can be divided into 'lite' beverages (those that are artificially sweetened or explicitly declared as being a 'diet', 'lower calorie', 'lite' or 'less in sugar' on the package) and regular beverages (those that are sugar-sweetened or drinks with no declarations about 'diet', 'lower calorie' or 'less in sugar' but usually contain naturally occurring sugar, e.g. fruit juice).

Data were collected using bespoke smartphone applications (apps) which were developed prior to the current study and outlined in more detail elsewhere⁽²²⁾. For data entry and quality purposes, photographs of the front of the package, Nutrition Information Panel and ingredients list were taken for each product. Data from each country were automatically entered into specially developed software or Microsoft® Excel for manual value range checks and data cleaning. Data were checked by a researcher from each country (M.P.P., H.E., E.D. and A.S.) and when values for outcome variables were substantially

outside of the range, they were checked using source documents (photographs) and amended where necessary.

Products were placed into six categories based on the standard categorisation system of the Global Food Monitoring Group⁽²¹⁾. These were: (i) soft drinks (e.g. cola and other fizzy drinks); (ii) fruit-flavoured & iced-tea drinks (e.g. fruit-based drinks which usually contain less diluted fruit juice and added sugar, and iced teas); (iii) fruit & vegetable juices (e.g. shelf-stable and refrigerated orange juice, apple juice, tomato juice); (iv) energy drinks (caffeine- and/or taurine-containing drinks); (v) sport (electrolyte) drinks (drinks specifically targeted at sport preparation, improvement, recovering); and (vi) flavoured waters (e.g. vitamin water). Cordials (powdered concentrate and liquid) and hot drink mixes (such as hot chocolate, coffee) were excluded because their serving size and energy content (in the unprepared form) differ greatly from that of ready-to-drink beverages. Plain waters were also excluded because Nutrition Information Panels and serving size data were not mandatory or not available for many of these products. Milk and milk substitutes (i.e. soya/rice milk) were excluded because milk is generally considered part of a healthy diet.

All sweet beverages were then further categorized into two types: (i) individual pack size (IPS) drinks, which were packages containing an amount that is reasonable to consume in one sitting (e.g. a 500 ml bottle); and (ii) bulk pack size (BPS) drinks, which were packages containing an amount that is reasonable to consume over more than one sitting (e.g. a 2000 ml bottle). Packages with a volume of 600 ml or less and displaying a manufacturer recommendation of one or two servings per package were included as IPS drinks⁽²³⁾. Packages with a volume of more than 600 ml were included as BPS drinks. However, some exceptions were made. Packages larger than 600 ml that specifically indicated on the Nutrition Information Panel to contain one serving were included as IPS drinks. Packages of 600 ml or less that specified on the Nutrition Information Panel to contain three or more servings were included as BPS drinks. These values and exceptions were chosen for several reasons. First, packages that contain two servings are customarily consumed at a single eating occasion⁽²⁴⁾. Second, it was previously emphasized that the serving size of IPS drinks did not always correspond with the size of the package and thus the amount consumed in one sitting⁽¹⁴⁾. Third, there are differences in serving size regulations across various brands and countries (e.g. a 500 ml bottle of soft drink in the Netherlands is commonly intended to contain two servings whereas a 600 ml bottle of soft drink in New Zealand is commonly intended to contain one serving). Multi-packs (e.g. a six-pack containing six cans or a family package containing four 1.5 litre bottles) were excluded.

Analyses were conducted separately for the two package size categories. To gain insight into how often different serving sizes were used in each country, serving sizes were further divided into five sub-categories based on the

Canadian regulations for sweet beverages^{*(10)}: (i) <250 ml; (ii) 250 to <312.5 ml; (iii) 312.5 to <375 ml; (iv) 375 to <600 ml; and (v) >600 ml. To gain insight into how often different package sizes were for sale, similar categories were used for IPS drinks and for BPS drinks the following sub-categories were used: (i) ≤1000 ml; (ii) >1000 to ≤1500 ml; (iii) >1500 to ≤2000 ml; (iv) 2000 to ≤2500 ml; and (v) >2500 ml.

Statistical analysis

Data were analysed in the statistical software package IBM SPSS Statistics version 21. Descriptive statistics were undertaken for the mean (and standard deviation), range and median serving size and package size. The percentage of products within each serving size category was calculated for both IPS and BPS drinks, for each country separately. In addition, the number of different serving sizes for each beverage category was calculated for all countries together and for each country separately. In the main analysis, all beverages (both sugar- and artificially sweetened) were included because the study focused on differences between countries in serving or package size, rather than drink category or nutrient content. However, secondary analyses were conducted to provide insight into the main differences in package size and serving size for the included beverage categories and for the differences in serving sizes for regular *v.* lite drinks.

For the main analysis, ANOVA tests were conducted to determine differences in mean package and recommended serving sizes between countries. Where significant differences were observed, Fisher's least significant difference *post hoc* analyses were conducted to determine for which countries these determinants differed. The *t* test was used to determine the differences in serving sizes (dependent variable) for single serving or multiple serving containers within each country. Similar tests were conducted to determine differences in mean package or recommended serving size between different beverage categories or for regular *v.* lite drinks. All tests were two-sided and $\alpha = 0.05$ was used for all analyses. As such, multiple tests were not accounted for. However, they were considered in assessing the results.

Results

Overall, data on 3230 beverage items in four countries were collected. Beverages with missing package or serving size data were excluded ($n = 113$)† to give a final

* These regulations include a reference amount and a range for servings for soft drinks, sport drinks and fruit juices. For soft drinks, the reference amount is 355 ml (range 250 to 375 ml). For sport drinks, the reference amount is 500 ml (range 400 to 600 ml). For juices the reference amount is 250 ml (range 175 to 250 ml).

† Data were incomplete or missing only for Dutch ($n = 79$, 69.9%) and Australian ($n = 34$, 30.1%) beverages and most commonly for regular drinks ($n = 107$; 94.7%).

sample of 3117 (891 IPS drinks and 2226 BPS drinks). Of the 2226 BPS drinks, 322 were excluded as they were bundle packages (e.g. a six-pack of IPS drinks). Therefore, 891 IPS drinks and 1904 BPS drinks were included in the final analysis (Fig. 1).

The mean (sd) kJ/100 ml of the included regular beverages for Australia, Canada, the Netherlands and New Zealand was 175.4 (44.2), 179.3 (56.1), 158.5 (53.9) and 179.5 (53.7) consecutively. Mean kJ/100 ml of regular beverages was significantly lower in the Netherlands compared with the other countries ($F=47.7$, $P<0.00$). The mean (sd) kJ/100 ml of the included lite beverages for Australia, Canada, the Netherlands and New Zealand was 8.4 (9.9), 9.6 (27.7), 21.4 (30.6) and 22.6 (41.6) consecutively. Mean kJ/100 ml content of Dutch and New Zealand lite beverages was significantly higher

compared with Australian and Canadian lite beverages ($F=5.16$, $P=0.02$).

Package size and serving size of individual pack size drinks

Package size

Both package and serving size of IPS drinks ranged from 118 ml (sport drink packaged in metallic pouch; Canada and Australia) to 1000 ml (plastic bottle of sport drink; New Zealand). For all countries, the median package size was 355 ml, which was on average 25 ml more than the median serving size (330 ml). The mean package size of IPS drinks was significantly different between all the countries ($F=25.3$, $P<0.00$; Table 1). Figure 2 illustrates how the package size of the exact same product varied within and

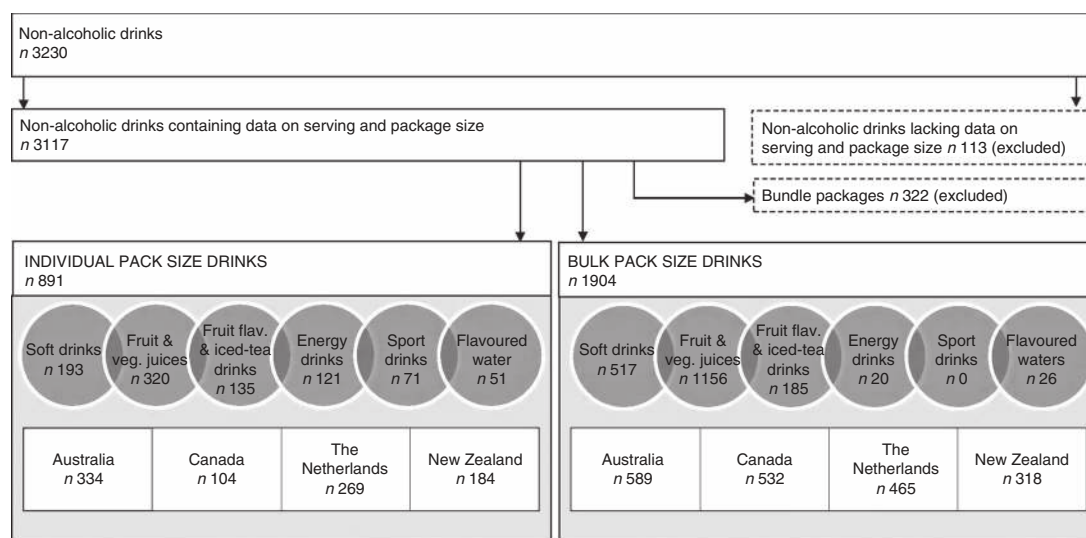


Fig. 1 Flowchart showing the included sweet beverages (veg., vegetable; flav., flavoured)

Table 1 Package size and serving size of individual pack size drinks (non-alcoholic sweet beverages) for sale in market-leading supermarkets of four high-income countries in 2012/2013

						< 250 ml†		250 to <312.5 ml†		312.5 to <375 ml†		375 to <600 ml†		> 600 ml†	
	<i>n</i>	Mean*	sd*	Range*	Median*	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Package size															
Australia	334	370 ^a	149	118–750	340	38	11	112	34	67	20	102	31	15	4
Canada	104	450 ^b	173	118–710	473	13	13	12	12	21	20	36	34	22	21
The Netherlands	269	399 ^c	110	150–568	400	11	4	46	17	70	26	142	53	–	–
New Zealand	184	484 ^d	191	200–1000	500	4	2	29	16	43	23	69	38	39	21
All countries	891	412	157	118–1000	355	66	7	199	22	201	23	349	39	76	9
Serving size															
Australia	334	341 ^a	145	118–750	287.5	62	19	124	37	58	17	80	24	10	3
Canada	104	363 ^a	154	118–710	347.5	18	17	29	28	24	23	23	22	10	10
The Netherlands	269	302 ^b	100	100–568	250	46	17	107	40	70	26	46	17	–	–
New Zealand	184	473 ^c	193	200–1000	500	9	5	31	17	43	23	63	34	38	21
All countries	891	359	159	118–1000	330	135	15	291	33	195	22	212	24	58	6

a,b,c,d Mean values within a column with unlike superscript letters were significant different ($P<0.05$): results of ANOVA tests with mean package size or mean serving size as dependent variable and country as independent variable.

*In millilitres.

†Number and percentage of package sizes or serving sizes within the serving size categories.



Fig. 2 Individual package sizes for regular Coca Cola in four high-income countries (2012–2013)

between different countries at the time of the measurements for the present paper. Most (39%) individual pack sizes were between 375 and 600 ml. The exception was Australia where most of the packages (34%) were between 250 and 312.5 ml. No IPS drinks above 600 ml were available in the Netherlands, and only 5% of the packages ($n = 15$) were above 600 ml in Australia. In contrast, 21% of IPS packages were above 600 ml in Canada and New Zealand (Table 1). Secondary analysis showed that for all countries, the package size of flavoured waters and sport drinks was

significantly the biggest and the package size of fruit & vegetable juices the smallest (Table 2).

Serving size

With the exception of Australian and Canada, the mean serving size was significantly different between all the countries (Table 1). Moreover, a wide variety of serving sizes for IPS drinks were available. For example, of all IPS soft drinks ($n = 193$), twenty-two different serving size recommendations were provided, ranging from 150 to 710 ml (see Supplemental Table 1 in the online supplementary material).

Differences in mean serving size were observed across beverage categories for all countries. However, secondary analysis showed that New Zealand displayed significantly larger mean (SD) serving sizes for sport drinks (752 (150) ml, $F = 17.7$, $P < 0.00$) and fruit & vegetable juices (330 (93) ml, $F = 11.2$, $P < 0.00$) compared with Australia (554 (134) ml and 262 (75) ml), Canada (507 (224) ml and 243 (50) ml) and the Netherlands (387 (125) ml and 265 (77) ml). The Netherlands had smaller mean (SD) serving sizes (278 (67) ml, $F = 23.0$, $P < 0.00$) for soft drinks compared with Australia (374 (113) ml), Canada (397 (150) ml) and New Zealand (445 (148) ml).

The mean (SD) serving size of lite IPS drinks was significantly higher in Australia (lite: 404 (131) ml *v.* regular: 336 (145) ml, $t = 2.44$, $P = 0.02$) and New Zealand (lite: 595 (208) ml *v.* regular: 458 (187) ml, $t = 2.87$, $P < 0.00$) compared with regular drinks. This was opposite in the Netherlands (lite 271 (68) ml *v.* regular 308 (105) ml, $t = -3.14$, $P < 0.00$), while in Canada no significant difference between lite and regular mean serving sizes was found (lite 349 (92) ml *v.* regular 366 (165) ml, $t = -0.6$, $P = 0.54$).

Package or serving size of bulk pack size drinks

Package size

Package size of BPS drinks across all countries ranged from 400 ml (Australia) to 3000 ml (Australia, Canada, New Zealand). Compared with other countries, the Netherlands had significantly smaller BPS drinks ($F = 21.6$, $P < 0.01$; Table 3). However, the mean serving size of BPS drinks was significantly different across all the countries ($F = 118.7$, $P < 0.00$). Secondary analysis indicated that, for all countries, soft drinks and fruit-flavoured & iced-tea drinks were most often available in packages of >1000 to ≤ 1500 ml whereas flavoured waters, fruit & vegetable juices and energy drinks were most often available in packages of 1000 ml or less (Table 2). BPS sport drinks were not available.

Serving size

The serving size presented on BPS drinks ranged from 90 ml (New Zealand) to 355 ml (Canada) and the mean serving size of all countries was 231 (SD 32) ml. The mean serving size of BPS drinks was significantly different across

Table 2 Mean, standard deviation and median package size, and number and percentages within package size categories, according to beverage category, of drinks (non-alcoholic sweet beverages) for sale in mark-leading supermarkets of four high-income countries in 2012/2013

	<i>n</i>	Mean*	SD*	Median*	<250 ml†		250 to <312.5 ml†		312.5 to <375 ml†		375 to <600 ml†		>600 ml†	
					<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Individual pack size drinks														
Soft drinks	193	403 ^a	131	355	14	7	21	11	77	40	74	38	7	4
Fruit & vegetable juices	320	328 ^b	117	300	50	16	120	37	67	21	76	24	7	2
Fruit-flavoured & iced-tea drinks	135	466 ^c	121	500	—	—	13	10	27	20	82	60	13	10
Energy drinks	121	389 ^a	130	350	—	—	43	36	25	21	52	43	1	—
Sport drinks	71	602 ^d	164	600	2	3	2	3	1	1	43	61	23	32
Flavoured waters	51	612 ^d	153	600	—	—	—	—	4	8	22	43	25	49
	<i>n</i>	Mean†	SD	Median†	≤1000 ml†		>1000 to ≤1500 ml†		>1500 to ≤2000 ml†		>2000 to ≤2500 ml†		>2500 ml†	
					<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Bulk pack size drinks														
Soft drinks	517	1483 ^a	365	1500	56	11	343	65	108	21	9	2	1	—
Fruit & vegetable juices	1156	1497 ^a	583	1500	491	43	173	15	393	34	37	3	62	5
Fruit-flavoured & iced-tea drinks	185	1425 ^a	309	1500	28	15	129	70	28	15	—	—	—	—
Energy drinks	20	1485 ^a	672	1000	11	55	2	10	5	25	—	—	2	10
Sport drinks	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Flavoured waters	26	1096 ^b	275	1000	14	54	12	46	—	—	—	—	—	—

a,b,c,d Mean values within a column with unlike superscript letters were significant different ($P < 0.05$): results of ANOVA tests with mean package size as dependent variable and beverage category as independent variable.

*In millilitres.

†Number and percentage of individual pack size drinks and bulk pack size drinks within the package size categories.

Table 3 Package size and serving size of bulk pack size drinks (non-alcoholic sweet beverages) for sale in market-leading supermarkets of four high-income countries in 2012/2013

						≤ 1000 ml†		>1000 to ≤1500 ml†		>1500 to ≤2000 ml†		>2000 to ≤2500 ml†		>2500 ml†	
	<i>n</i>	Mean*	sd*	Range*	Median*	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Package size															
Australia	589	1542 ^a	595	400–3000	1250	170	29	198	33	152	26	31	5	38	7
Canada	532	1550 ^a	434	750–3000	1750	145	27	73	14	312	59	1	–	1	–
The Netherlands	465	1313 ^b	323	460–2000	1500	171	37	255	55	39	8	–	–	–	–
New Zealand	318	1481 ^a	595	750–3000	1500	114	36	133	42	31	10	14	4	26	8
All countries	1904	1479	506	400–3000	1500	600	32	659	35	534	28	46	2	65	3
						<250 ml†		250 to <312.5 ml†		312.5 to <375 ml†		375 to <600 ml†		>600 ml†	
	<i>n</i>	Mean*	sd*	Range*	Median*	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Serving size															
Australia	589	223 ^a	29	100–250	240	295	50	294	50	–	–	–	–	–	–
Canada	532	248 ^b	31	100–355	200	78	15	435	81	19	4	–	–	–	–
The Netherlands	465	216 ^c	30	100–280	200	288	62	177	38	–	–	–	–	–	–
New Zealand	318	240 ^d	26	90–330	250	62	20	255	80	1	0	–	–	–	–
All countries	1904	231	32	90–355	250	723	38	1164	61	20	1	–	–	–	–

a,b,c,d Mean values within a column with unlike superscript letters were significant different ($P < 0.05$): results of ANOVA tests with mean package size or mean serving size as dependent variable and country as independent variable.

*In millilitres.

†Number and percentage of package sizes within the package size categories.

‡Number and percentage of serving sizes within the serving size categories.

all the countries ($F = 118.7$, $P < 0.00$). Also, a large number of different serving sizes were displayed on BPS drinks. For example, for the 520 multi-serving containers of soft drinks included, eleven different serving size

recommendations were displayed (see Supplemental Table 1 in the online supplementary material).

Including all countries, secondary analysis revealed differences in mean serving size of soft drinks ($F = 33.5$,

$P < 0.00$) and fruit & vegetable juices ($F = 179.3$, $P < 0.00$). *Post hoc* analysis indicated that the Netherlands had significantly smaller mean (sd) serving sizes for soft drinks (238 (27) ml) and fruit & vegetable juices (217 (25) ml), and Canada had significantly larger serving sizes for soft drinks (272 (43) ml) and fruit & vegetable juices (242 (56) ml), compared with the other countries.

In all countries, the mean (sd) serving size of lite BPS drinks was significantly larger than the serving size of regular drinks; Australia (lite: 248 (11) ml *v.* regular: 221 (29) ml, $t = 14.2$, $P < 0.00$), Canada (lite: 265 (37) ml *v.* regular: 245 (29) ml, $t = 3.96$, $P < 0.00$), the Netherlands (lite: 234 (29) ml *v.* regular: 211 (29) ml, $t = 6.70$, $P < 0.00$) and New Zealand (lite: 249 (8) ml *v.* regular: 238 (27) ml, $t = 3.41$, $P < 0.00$).

Individual pack size drinks *v.* bulk pack size drinks

The mean serving size of IPS drinks (359 ml) was 128 ml larger than the mean serving size of BPS drinks (231 ml; $t = 23.9$, $P < 0.00$). This trend was seen for all countries, with the largest difference for New Zealand (233 ml; 473 *v.* 240 ml), followed by Australia (118 ml; 341 *v.* 223 ml), Canada (115 ml; 363 *v.* 248 ml) and the Netherlands (86 ml; 302 *v.* 216 ml; Tables 1 and 3). In all countries, a wide range of serving sizes was used to provide information on the amount appropriate to consume in one sitting (Tables 1 and 3). However, a large number of different serving sizes was observed more often for IPS drinks than for BPS drinks. Also, the median serving size of the beverage categories included was smaller for BPS drinks than for IPS drinks, with an exception for fruit & vegetable juices (see Supplemental Table 1 in the online supplementary material).

Discussion

As hypothesized, there was substantial variation within and between the four high-income countries with respect to package and recommended serving sizes of IPS drinks and BPS drinks; even package and serving sizes of the same beverages of the same brand were found to vary internationally. Moreover, there was a substantial difference in recommended serving sizes between IPS drinks and BPS drinks. Nevertheless, this finding is in line with Canadian regulations allowing single serving containers to be bigger than the suggested reference serving size to be classified as 'one serving', provided they are deemed a reliable amount to consume in one sitting (as determined by the manufacturer)⁽¹⁰⁾. Greater variation in recommended serving size was also observed for IPS compared with BPS drinks. Moreover, secondary outcomes indicated that there was a large variety in package size and serving size for the different beverage categories, especially for IPS drinks. Another important finding is that New Zealand,

which has the third highest overweight and obesity rates according to the OECD⁽²⁵⁾, has consistently the largest package size and recommended serving size of IPS drinks of all four countries assessed.

Strengths of the study include that data were collected from major supermarkets, thus covering the most popular sweet beverages purchased in the four countries. Moreover, when the same beverage was presented in a range of different package sizes, data on all packages were taken into account. In doing so, differences in serving size of similar beverages were identified. Weaknesses of the study include the cross-sectional nature of the study and the exclusion of some beverage categories (e.g. cordials). Moreover, only beverages for purchase in the supermarket were included and it is possible that inclusion of beverages available in vending machines, smaller stores, cafeterias or cafés would have altered our findings. Nevertheless, it is difficult to know in which direction.

Results are consistent with previous research showing that countries and food manufacturers lack clear regulations regarding recommended serving sizes^(8,15). The considerable variation in serving size between countries likely reflects this lack of regulation. However, even in the presence of more consistent regulations, such as in Canada, substantial variation in serving size of sweet beverages was still found. Further, significantly smaller bulk package sizes were observed in the Netherlands, where no package or serving size regulations exist. This finding suggests that factors other than regulation play a role in manufacturer package and serving sizes. For example, cultural and social norms may influence package and serving sizes within a country⁽²⁶⁾; since the late 1950s BPS package sizes in the Netherlands doubled from 750 to 1500 ml⁽⁵⁾. However, in the USA the package sizes of IPS drinks increased up to ten times their original size⁽²⁷⁾. In order to prevent further and more excessive increases in pack size, regulations should now be considered.

A large number of recommended serving sizes were observed within and across the four countries in our study, especially for IPS drinks. This could be explained by differences in the presence or absence of serving size regulations and/or the reference amounts included in existing regulations. For example, soft drink servings can range from 250 to 375 ml according to the Canadian guidelines. Second, in countries where serving size labelling is voluntary, or in the absence of serving size regulations, manufacturer standards, which are likely to vary by company, might be used. Further, in the absence of regulation, a serving size could be chosen which makes a product appear healthier, to encourage increased consumption. However, the results presented in the current study cannot confirm this assumption. Nevertheless, providing manufacturers and thus consumers with standardized and regulated serving sizes would make it easier to compare products and assist individuals in making healthier food choices.

Our findings suggest that the current approach taken by Canada to allow a range of reference serving sizes for a

product is not optimal. A recent study indicated that individuals have difficulties in selecting appropriate amounts to consume because of a lack of clarity or irrelevance of suggested serving size guidance⁽²⁸⁾. Future serving size regulations need to be clearer and perhaps fixed for different types of beverages. An alternative is to provide nutrition information only per 100 ml. If voluntary efforts of the food industry to optimize the package and serving size regulation are ineffective, policy efforts should be considered⁽²⁹⁾.

In addition to more consistent regulation of serving sizes, additional strategies can be used to stimulate appropriate use of serving size guidance by consumers. People often have difficulties in determining appropriate portion sizes to consume and larger amounts than recommendations are often the social norm. Therefore, public awareness campaigns to educate people on appropriate serving sizes might be useful. In addition, labelling and food packages should become more supportive in their serving size guidance. A dual-column labelling approach, such as that used in New Zealand and Australia, or providing the energy content per container may help consumers to make more healthier choices for containers with two (or more) servings^(24,30). For multi-serving packages it may be helpful to provide serving size tools in household measures (e.g. one glass)⁽⁸⁾. Recently, the US Food and Drug Administration proposed to update the US Nutrition Facts label. The updated labels will include 'energy (kJ) per package' information and will communicate more realistic serving sizes⁽³¹⁾.

Because package size influences the amount consumed, package sizes may be even more important than serving size in the regulation of energy intake. Previous studies have indicated that people consume more in one sitting from larger packages than from smaller ones⁽³²⁾. In recent years, larger package sizes of sweet beverages have become available⁽⁵⁾, although industry has already introduced smaller packages for sweet beverages recently⁽³³⁾ in response to public health advocates. Nevertheless, as our research shows, large packages are still widely available. This was highlighted by the attempt of New York's former mayor Bloomberg to prohibit single-serving sugar-sweetened beverages larger than 16 fl oz (~473 ml), sold in restaurants, movie theatres and mobile food vendors⁽³⁴⁾. Moreover, value size pricing on larger packages makes it difficult for consumers to choose newly available smaller packages. Additionally, smaller package sizes may increase packaging costs for industry⁽³⁵⁾. Therefore, alongside the effort to standardize serving sizes, package size regulations should also be considered.

Conclusions

The present paper provides new evidence for inconsistencies in serving sizes and package sizes of pre-prepared sweet beverages in four high-income countries. A large range of package and serving sizes were displayed within and across

Australia, Canada, the Netherlands and New Zealand, making it difficult for people in these countries to make healthy beverage choices. Clear, consistent and appropriate serving sizes displayed on packages of sweet beverages are urgently needed for consumers. Serving size and potentially package size regulations, preferably set by governments and global health organisations, would provide this consistency. Finally, it is important to conduct longitudinal research and monitor package and serving sizes over time in response to regulation, political and non-political initiatives.

Acknowledgements

Acknowledgements: The authors would like to thank Dr Yannan Jiang (University of Auckland, New Zealand) for her advice on statistical analysis. **Financial support:** M.P.P. was supported by the EMGO+ Travel Grant of the EMGO+ Institute for Health and Care Research, VU University Medical Center, Amsterdam, the Netherlands. The study was funded by ZonMW, the Dutch Institute for Research in Health Care (project number 121020019). The Canadian data collection was funded by the Canadian Institute of Health Research. H.E. is supported by a Heart Foundation of New Zealand fellowship (#1463). The EMGO+ Travel Grant supported the travel of the principal author to undertake this research. The funders had no role in the design, analysis or writing of this article. **Conflict of interest:** B.N. was a Member of the Pepsico Global Scientific Advisory Board (2010–2012) and holds funding from the Australian Food and Grocery Council as part of a National Health and Medical Research Council of Australia Partnership project (2010–2014). The other authors have no conflict of interest to declare. **Authorship:** M.P.P., H.E. and C.N.M. contributed to the original design. M.P.P., H.E., E.D. and A.S. organised and/or conducted data collection. M.P.P., H.E., E.D. and A.S. were involved in reorganising and recoding the data for the final database. M.P.P., H.E. and C.N.M. conducted the statistical analyses. M.R.L., B.N., J.C.S. and I.H.M.S. were active in the interpretation of the results. The manuscript was drafted by M.P.P. and H.E. and reviewed by all authors. All authors have approved the final report. M.P. is the corresponding author for this study. **Ethics of human subject participation:** Ethics approval was not required.

Supplementary material

To view supplementary material for this article, please visit <http://dx.doi.org/10.1017/S1368980015001974>

References

1. Malik VS, Schulze MB & Hu FB (2006) Intake of sugar-sweetened beverages and weight gain: a systematic review. *Am J Clin Nutr* **84**, 274–288.

2. de Ruyter JC, Olthof MR, Seidell JC *et al.* (2012) A trial of sugar-free or sugar-sweetened beverages and body weight in children. *N Engl J Med* **367**, 1397–1406.
3. Dhingra R, Sullivan L, Jacques PF *et al.* (2007) Soft drink consumption and risk of developing cardiometabolic risk factors and the metabolic syndrome in middle-aged adults in the community. *Circulation* **116**, 480–488.
4. Blundell J, de Graaf C, Hulshof T *et al.* (2010) Appetite control: methodological aspects of the evaluation of foods. *Obes Rev* **11**, 251–270.
5. Steenhuis IH, Leeuwis FH & Vermeer WM (2010) Small, medium, large or supersize: trends in food portion sizes in The Netherlands. *Public Health Nutr* **13**, 852–857.
6. Wansink B (1996) Can package size accelerate usage volume? *J Mark* **60**, 1–14.
7. European Food Information Council (2013) Global Update on Nutrition Labelling. Executive Summary. http://www.eufic.org/upl/1/default/doc/GlobalUpdateExecSumFeb2013_FINAL.pdf (accessed April 2014).
8. Faulkner GP, Pourshahidi LK, Wallace JM *et al.* (2012) Serving size guidance for consumers: is it effective? *Proc Nutr Soc* **71**, 610–621.
9. Australian Government (2013) Australia New Zealand Food Standards Code – Standard 1.2.8 – Nutrition Information Requirements. <http://www.comlaw.gov.au/Details/F2013C00098> (accessed April 2014).
10. Canadian Food Inspection Agency (2014) Information within the Nutrition Facts Table – Mandatory Information. <http://www.inspection.gc.ca/food/labelling/food-labelling-for-industry/nutrition-labelling/information-within-the-nutrition-facts-table/eng/1389198568400/1389198597278?chap=1#s2c1> (accessed April 2014).
11. US Food and Drug Administration (2013) 7. Nutrition Labeling; Questions L1 through L153. Serving Size. <http://www.fda.gov/food/guidanceregulation/guidancedocuments/regulatoryinformation/labelingnutrition/ucm064904> (accessed April 2014).
12. Canadian Food Inspection Agency (2014) Information within the Nutrition Facts Table, Reference Amounts. <http://www.inspection.gc.ca/food/labelling/food-labelling-for-industry/nutrition-labelling/information-within-the-nutrition-facts-table/eng/1389198568400/1389198597278?chap=5#a5a2> (accessed April 2014).
13. Church S (2008) Trends in portion sizes in the UK – A preliminary review of published information. <http://www.food.gov.uk/multimedia/pdfs/reviewportions.pdf> (accessed April 2014).
14. Walker KZ, Woods JL, Rickard CA *et al.* (2008) Product variety in Australian snacks and drinks: how can the consumer make a healthy choice? *Public Health Nutr* **11**, 1046–1053.
15. Cleanthous X, Mackintosh AM & Anderson S (2011) Comparison of reported nutrients and serve size between private label products and branded products in Australian supermarkets. *Nutr Diet* **68**, 120–126.
16. Lewis HB, Ahern AL & Jebb SA (2012) How much should I eat? A comparison of suggested portion sizes in the UK. *Public Health Nutr* **15**, 2110–2117.
17. Raats MM, Hieke S, Jola C *et al.* (2015) Reference amounts utilised in front of package nutrition labelling; impact on product healthfulness evaluations. *Eur J Clin Nutr* **69**, 619–625.
18. European Parliament, Council of the European Union (2011) Regulation (EU) No 1169/2011 of the European Parliament and of the Council of 25 October 2011 on the provision of food information to consumers, amending Regulations (EC) No 1924/2006 and (EC) No 1925/2006 of the European Parliament and of the Council, and repealing Commission Directive 87/250/EEC, Council Directive 90/496/EEC, Commission Directive 1999/10/EC, Directive 2000/13/EC of the European Parliament and of the Council, Commission Directives 2002/67/EC and 2008/5/EC and Commission Regulation (EC) No 608/2004 Text with EEA relevance. <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32011R1169> (accessed April 2014).
19. Dunford E, Webster J, Metzler AB *et al.* (2012) International collaborative project to compare and monitor the nutritional composition of processed foods. *Eur J Prev Cardiol* **19**, 1326–1332.
20. Nederlandse Overheid (1991) Warenwetbesluit Voedingswaarde-informatie levensmiddelen (Act of the Netherlands Food and Consumer Product Safety Authority on Nutritional Information; Dutch Government). http://wetten.overheid.nl/BWBR0005310/geldigheidsdatum_04-03-2014 (accessed April 2014).
21. Food Monitoring Group (2012) International collaborative project to compare and track the nutritional composition of fast foods. *BMC Public Health* **12**, 559.
22. Dunford E, Trevana H, Goodsell C *et al.* (2014) FoodSwitch: A mobile phone app to enable consumers to make healthier food choices and crowdsourcing of national food composition data. *JMIR Mhealth Uhealth* **2**, e37.
23. Australian Food and Grocery Council (2011) Myth #4: Serving sizes will be manipulated to mislead consumers as to the proportion of energy or nutrients that a serve represents. <http://www.mydailyintake.net/food-diet-and-dig-myths/myth-4-serving-sizes-will-be-manipulated-to-mislead-consumer.html> (accessed April 2014).
24. Lando AM & Lo SC (2013) Single-larger-portion-size and dual-column nutrition labeling may help consumers make more healthful food choices. *J Acad Nutr Diet* **113**, 241–250.
25. Sassi F (2010) Obesity and the Economics of Prevention: Fit not Fat. <http://www.oecd.org/els/health-systems/46044572.pdf> (accessed April 2014).
26. Rozin P, Kabnick K, Pete E *et al.* (2003) The ecology of eating: smaller portion sizes in France than in the United States help explain the French paradox. *Psychol Sci* **14**, 450–454.
27. Young LR & Nestle M (2007) Portion sizes and obesity: responses of fast-food companies. *J Public Health Policy* **28**, 238–248.
28. Spence M, Livingstone MBE, Hollywood LE *et al.* (2013) A qualitative study of psychological, social and behavioral barriers to appropriate food portion size control. *Int J Behav Nutr Phys Act* **10**, 92.
29. Young LR & Nestle M (2012) Reducing portion sizes to prevent obesity a call to action. *Am J Prev Med* **43**, 565–568.
30. Vanderlee L, Goodman S, Sae Yang W *et al.* (2012) Consumer understanding of calorie amounts and serving size: implications for nutritional labelling. *Can J Public Health* **103**, 327–331.
31. US Food and Drug Administration (2014) Proposed Changes to the Nutrition Facts Label – Proposed serving size changes. <http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/LabelingNutrition/ucm385663> (accessed April 2014).
32. Zlatevska N, Dubelaar C & Holden SS (2014) Sizing up the effect of portion size on consumption: a meta-analytic review. *J Mark* **78**, 140–154.
33. The Coca Cola Company (2010) Providing information and choice. <http://www.coca-cola.co.uk/comingtogether/providing-information-and-choice.html> (accessed April 2014).
34. Pomeranz JL & Brownell KD (2012) Portion sizes and beyond – government's legal authority to regulate food-industry practices. *New Engl J Med* **367**, 1383–1385.
35. Vermeer WM, Steenhuis IHM & Seidell JC (2009) From the point-of-purchase perspective: a qualitative study of the feasibility of interventions aimed at portion-size. *Health Policy* **90**, 73–80.