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Beverage intake patterns of Canadian children and adolescents

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Abstract

Objective: Little is known of the beverage intake patterns of Canadian children or of characteristics within these patterns. The objective was to determine beverage intake patterns among Canadian children and compare intakes of fourteen types of beverages, along with intakes of vitamin C and Ca, and sociodemographic factors across clusters.
Design: Dietary information was collected using one 24 h recall. Sociodemographic data were collected by interview. Cluster analysis was used to determine beverage intake patterns. Pearson's χ^2 and 95 % CI were used to test differences across clusters.
Setting: Data from the Canadian Community Health Survey Cycle 2·2.
Subjects: Children aged 2–18 years with plausible energy intake and complete sociodemographic data (n 10 038) were grouped into the following categories: 2–5-year-old boys and girls, 6–11-year-old girls, 6–11-year-old boys, 12–18-year-old girls and 12–18-year-old boys.
Results: Five beverage clusters emerged for children aged 2–5 years, six clusters for children aged 6–11 years (both sexes) and four clusters for those aged 12–18 years (both sexes). Sweetened beverage clusters appeared in all age–sex groups. Intakes of sweetened beverages ranged from 553 to 1059 g/d and contributed between 2 % and 18 % of total energy intake. Girls 6–11 years of age in the 'soft drink' cluster had lower Ca intake compared with other clusters in that age–sex group. Age and ethnicity differed across clusters for most age–sex groups. Differences for household food security status and income were found; however, no pattern emerged.
Conclusions: Patterns in beverage intake among Canadian children include beverages that are predominantly sugar sweetened. Public health nutrition professionals can use knowledge about beverage patterns among children, as well as the characteristics of these groups, in the development of nutritional programmes and policies.

Keywords
Sugar-sweetened beverages
Children
Cluster analysis
Canadian Community Health Survey
Dietary intake

Expert panels have recommended limiting sweetened beverage intake for the general population in the USA and Mexico[1,2]. Canada's Food Guide recommends limiting sweetened beverage intake but does not provide details on the amount and frequency of consumption[3]. Recommendations to limit sweetened beverages and juice have been made for children as they relate to childhood obesity or overnutrition[4,5]. Despite this, consumption of sweetened beverages has increased over time among American adults and children[6,7]. In Canada, no national trend data on consumption are available; however, data on beverage disappearance suggest that soft drink intake has doubled between 1980 and the 2000s, whereas milk intake has decreased[8]. Food disappearance data do not provide consumption patterns of specific groups such as children. Thus, there is a need in Canada to identify and describe beverage consumption patterns, especially of children, in order to develop targeted policies and programmes that aim to reduce sweetened beverage consumption among the highest consumers.

The Canadian Community Health Survey (CCHS) is a national annual cross-sectional survey; however, to date, only one cycle, cycle 2·2 in 2004, has collected dietary data. This is the most recent national-level nutritional survey available in Canada in over 30 years. The objective of the present study was to use CCHS 2·2 to identify beverage patterns among Canadian children aged 2–18 years and to describe and compare beverage intake and sociodemographic characteristics across the resulting beverage patterns.

Experimental methods

Data from CCHS cycle 2·2 included dietary information collected by means of a 24 h recall using the Automated Multiple Pass Method (AMPM)[9]. Data from a single 24 h recall were collected by trained interviewers using computers, following the five steps of the AMPM: quick list; forgotten foods and beverages; time and occasion; detailed

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information including amounts consumed and preparation method; and a final review[10]. Participants could report the amount of beverages consumed as volume, container type, or choice of standard images of various sizes of glasses and mugs. Children aged ≥12 years provided their own dietary recall data, whereas children aged 6–11 years provided dietary information along with their parent or caregiver. Children under 6 years of age had a parent or caregiver to report their food intake[10]. Weighting adjustments were applied to reduce seasonal and weekday variations in dietary recall information, where the proportion of those interviewed each season corresponded to one-quarter of the total population and the proportion interviewed on a weekday (Monday through Thursday) corresponded to four-sevenths of the population[11].

CCHS 2·2 used interviews to gather data on demographics and at socio-economic levels. Ethnicity was self-reported and, because of small cell size, collapsed into two categories: white and non-white. Household income was based on self-reported income before taxes and on the number of people per household. Because of small cell sizes, income has been reported as low and high. Low household income was considered ≤$CAN 15 000 if one to two people lived in the household, ≤$CAN 20 000 if three to four people lived in the household and ≤$CAN 30 000 if five or more people lived in the household. High income was the reverse of these categories. Household food security was based on responses to the Household Food Security Survey Module[10]. Food insecure included both moderate and severe levels. Household education was the highest level of education attained by any member of the household. Individuals with a low level of education were defined as those who had obtained secondary-school graduation or lower. Individuals with high level of education were those who had attained at least some amount of post-secondary school education. Additional details on CCHS 2·2 can be found elsewhere[12].

The CCHS 2·2 comprised a final sample of 35 107 participants of all age groups. We used data from children aged 2–18 years (*n* 13 824) and used the age categories of 2–5, 6–11 and 12–18 years to compare with other studies on beverage consumption[6,13,14]. The inclusion criteria to arrive at a sample of 10 038 were: valid 24 h recall data (as determined during the interview); complete data for household income, household education, household food security and ethnicity; sex-specific BMI-for-age that was greater than the 5th percentile, as in the study by LaRowe *et al.*[13]; feeding not only breast milk (for children aged 2–5 years); not pregnant or breast-feeding (for girls aged 12–18 years); and plausible energy intakes. Implausible energy intakes were either <3374 kJ (<800 kcal)/d or >11 297 kJ (>2700 kcal)/d[11] for children aged 2–5 years; <3766 kJ (<900 kcal)/d or >14 644 kJ (>3500 kcal)/d for children aged 6–11 years[13]; and <5021 kJ (<1200 kcal)/d or >20 502 kJ (>4900 kcal)/d for children aged 12–18 years, which is equal to 10 % less than the lowest calculated estimated energy requirement (EER) and 10 % more than the highest EER for that age group, rounded to the nearest 100 units.

Beverage pattern formation

Beverages consumed were identified and extracted from the CCHS 2·2 data files. These were categorized on the basis of energy and nutrient content (Table 1) and on Canadian

Table 1 Classification by category and type for beverages

Beverage category	Type of beverages in the category
Sugar-sweetened low nutrient	
Fruit drinks	Fruit drink containing <100 % fruit juice from concentrate, fruit-flavoured beverages, such as lemonade, fortified or not
Regular soft drinks	Carbonated beverages, colas, clear sodas, fruit-flavoured sodas (e.g. lemon-lime, orange, etc.), non-alcoholic beer
Tea (sweetened)	Iced tea, spiced, instant
Coffee (sweetened)	Instant, brewed, flavoured (e.g. cappuccino, mocha, but with whitener not milk)
Nutrient-based beverages	
Plain milk	Skimmed, 1 % milk fat, 2 % milk fat and whole milk (includes those with added milk solids, diluted evaporated milk, with extra Ca)
Milk-based beverages: high fat (>2 % milk fat)	Milk shakes, iced cappuccino, eggnog, whole chocolate milk, hot chocolate with whole milk, (all) malted milk unless specified with low-fat milk, coffee substitute mixed with whole milk, milk-based smoothie, latte, café au lait
Milk-based beverages: low fat (≤2 % milk fat)	Skimmed milk latte, low-fat chocolate milk (or where milk fat has not been specified), mixed milk beverages where low-fat milk has been specified (e.g. eggnog mix, instant breakfast)
Other types of milk	Soya-based beverages, goat milk, rice beverage, whey beverage, buttermilk, sheep milk, protein shakes
Vegetable juice	100 % vegetable juice (carrot, tomato)
Fruit juice	100 % fruit juice, sweetened fruit juice
No additional energy/energy from beverages	
Water	Tap and bottled water, club soda, sparkling water
Diet drinks	Colas and non-colas with sugar substitutes, fruit drinks with aspartame or sucralose, ‘low-calorie’, non-alcoholic wine
Tea	No added sugar/cream; brewed, instant, herbal
Coffee	No added sugar/cream; brewed, instant, caffeinated, decaffeinated, chicory

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recommendations, in which, for example, skimmed 1 % milk fat (MF) and 2 % MF milk are all considered low-fat milk[3]. Beverage weight in grams was used in all analyses.

Cluster analysis was used to classify children into clearly distinct groups on the basis of the dominant pattern of beverage intake. *K*-means cluster analysis was performed for each age–sex group using categories of beverages as described in Table 1. The FASTCLUS procedure categorized participants into non-overlapping groups in an iterative process by comparing Euclidean distances[15]. As the procedure is sensitive to outliers, participants were removed if the intake of beverage group was ≥5 SD from the mean intake of the specific beverage category. These participants were returned to the data set once the optimal number of clusters was determined. With the *K*-means method, it was necessary to predefine the number of clusters. This procedure was commenced with forty clusters, and clusters with five or fewer members were temporarily removed.

The optimal number of clusters was determined using the cubic clustering criterion (CCC), pseudo-F statistic (PFS) and interpretability. The values of CCC and PFS for each cluster set (three to twenty cluster sets) were recorded and then assessed using a line graph to identify peaks in the values. The cluster set(s) at which CCC and PFS both peaked was (were) explored for a clear and unique pattern of intake for each cluster, and the best cluster solution was then determined.

Before finalizing the clusters for each category, an exploratory analysis was completed examining the impact of combining sweetened beverage categories, as well as the impact of water, on the clustering process. Combining sweetened beverage categories did not result in improved clustering. When water was included in the cluster analysis (fourteen beverage categories) as a separate beverage, the CCC and PFS did not produce early and positive peaks, as necessary for interpretation. A similar exploratory analysis was performed for all age–sex groups, and late and multiple peaks for CCC and PFS occurred repeatedly when water was included as a unique beverage group (data not shown). The decision was thus made to exclude water as a separate beverage category from the clustering process (resulting in thirteen beverage categories used for clustering) and to describe the intake of water within all clusters that emerged.

Statistical analysis

Means, SEM and 95 % CI were calculated for beverage intake for each cluster across the age–sex groups. Data on percentage of energy from beverages, percentage of energy from sweetened beverages and percentage of energy from nutrient-based beverages, as well as vitamin C and Ca intakes – as they are key nutrients in beverages – by cluster were also examined. Sociodemographic characteristics were compared across clusters. To test differences in categorical variables across beverage patterns, the χ^2 test was used. For continuous variables, 95 % CI were examined and the results were considered to be statistically significant when no overlap existed[10].

All analyses were weighted to obtain estimates at a population level. Bootstrapping was used, as recommended by Statistics Canada, to account for the complex survey design[12]. Alpha was set at 0·05. Statistical software packages used in various stages of analyses included SAS version 9·2 (SAS Institute Inc., Cary, NC, USA), STATA versions 10·0 and 11·0 (StataCorp LP, College Station, TX, USA), SPSS version 16·0 (SPSS Inc., Chicago, IL, USA) and Microsoft Excel 2007 (Microsoft Corporation, Redmond, WA, USA).

Results

Cluster analysis was completed separately for five age–sex groups: 2–5-year-olds; 6–11-year-old boys and girls; and 12–18-year-old boys and girls. For children aged 2–5 years, a five-cluster solution was determined to be the most appropriate. The most appropriate clustering patterns for older children were a six-cluster solution for both boys and girls aged 6–11 years and a four-cluster solution for boys and girls aged 12–18 years. The beverage clusters were named using the predominant beverage. All age–sex groups contained a cluster in which no dominant pattern of beverage intake existed, wherein these groups were classified as 'moderate' clusters. Intakes of beverages such as vegetable juice, diet drinks, tea and coffee were so low as to not contribute significantly to intake.

Beverage intakes by cluster

Among 2–5-year-olds within each beverage cluster, the defining beverage intake was the highest intake (Table 2). Total beverage intake was lowest among those in the 'moderate' cluster. Boys aged 6–11 years who drank mostly fruit drinks drank a relatively small amount of fruit juice (Table 3); however, boys who drank mostly fruit juice drank less fruit drink. Boys in the 'milk' cluster drank 859 g of milk, whereas boys in other clusters drank <250 g of milk (Table 3). There was no significant difference in water intake across clusters. Girls aged 6–11 years who drank mostly fruit drinks drank less fruit juice (Table 3). Similar to boys, girls who drank mostly fruit juice drank relatively less fruit drink. Girls who were in the 'soft drink' cluster drank 467 g of soft drinks on the previous day. Girls in the 'milk' cluster drank 722 g of milk, whereas consumption of milk among other clusters was <200 g (Table 3). Those who were in the moderate cluster had the lowest total beverage intake compared with all other clusters. There was no significant difference across clusters for water intake.

Data for beverage intake by cluster of adolescent boys and girls aged 12–18 years (Table 4) showed that adolescent boys in the 'milk' cluster drank >1000 g of milk on the day of the recall, which was nearly half of their total beverage intake. Adolescent boys in the 'soft drink'

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Table 2 Mean intake of selected beverage groups, selected nutrients and energy, as well as sociodemographic characteristics, by beverage cluster in children aged 2–5 years

	Fruit drink (*n* 315)		Fruit juice (*n* 320)		Milk (*n* 422)		High-fat milk (*n* 268)		Moderate (*n* 825)		
	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	
Beverage intake by cluster (g)											
Fruit drink	556*	19	68	11	94	11	96	19	73	5	
Soft drink	21	5	23	6	11	3	15	4	35[a]	6	
Milk	222	16	222	18	787*	24	46*	14	206	8	
High-fat milk	52	10	65[b]	12	48	12	688*	47	32	4	
Fruit juice	56*	13	719*	43	138	12	135	17	109	6	
Water	316	30	274	28	352	28	276	27	332	18	
Total beverage intake	1275[a]	48	1426	62	1461	44	1304	71	865*	23	
Nutrient and energy intakes by cluster											
%E from beverages	28[ac]	1	33	1	32	1	34	1	18*	0	
%E from SSB	16*	1	2	0	3	0	3	1	3	0	
Ca (mg)	863[ac]	27	897[ac]	28	1418	35	1271	62	816[ac]	21	
Vitamin C (mg)	165*	11	267*	12	121	5	125	6	112	4	
Sociodemographic characteristics by cluster	%		%		%		%		%		*P* value
Age (years)	3·6		3·6		3·5		3·2[d]		3·6		
Sex (female)†	51·0		38·9		46·3		49·0		55·4		0·032
Ethnicity (non-white)†	20·4		14·5		19·8		34·3		21·8		0·006
Household income level (low)	14·3		6·4		7·6		11·0		9·6		0·09
Food security (insecure)	13·3		9·8		11·8		7·8		8·4		0·46
Household educational level (secondary or lower)	18·6		16·1		12·8		13·5		16·3		0·64

%E, percentage of energy; SSB, sugar-sweetened beverages.
Mean values within rows with unlike superscript letters were significantly different from the [a]milk cluster, [b]moderate cluster, [c]high-fat milk cluster and [d]juice cluster.
*Significantly different from other clusters.
†Significantly different across beverage patterns using Pearson's χ^2 test ($P < 0·05$).

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Table 3 Mean intake of selected beverage groups, selected nutrients and energy, as well as sociodemographic characteristics, by beverage cluster in boys and girls aged 6–11 years

	Boys													Girls												
	Soft drink (*n* 219)		Fruit drink (*n* 275)		Fruit juice (*n* 192)		Milk (*n* 322)		High-fat milk (*n* 144)		Moderate (*n* 630)			Soft drink (*n* 193)		Fruit drink (*n* 326)		Fruit juice (*n* 206)		Milk (*n* 348)		High-fat milk (*n* 139)		Moderate (*n* 619)		
	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM		Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	
Beverage intake by cluster (g)																										
Fruit drink	151	17	708*	19	64*	13	141	17	143	18	111	8		111	15	622*	21	121	26	76	10	142	31	97	8	
Soft drink	553*	29	72[a]	14	54	14	32	8	64[a]	15	23	4		467*	23	42	9	52	14	38	7	57[a]	14	22	4	
Milk	210	17	220	18	214	26	859*	18	70*	17	248	10		142	16	189	12	181	19	722*	17	172	34	170	10	
High-fat milk	34	8	32	7	32	10	38	9	609*	59	23	5		25	9	30	7	28	9	50[a]	10	472*	30	16	4	
Fruit juice	109	29	58	13	653*	29	112[ab]	13	140[ab]	24	71	7		70	13	56	9	572*	36	87	10	106	19	65	6	
Water	531	56	385	36	383	62	366	36	601	95	448	31		326	47	417	38	375	47	403	33	497	62	422	28	
Total beverage intake	1681	81	1542	55	1459	79	1644	53	1693	140	1048*	31		1195	67	1409	47	1383	54	1445	43	1497	100	898*	31	
Nutrient and energy intakes by cluster																										
%E from beverages	23	1	24	1	24	1	27	1	28[c]	2	15*	1		21	1	23	1	24	1	25	1	28[c]	2	13*	1	
%E from SSB	14	1	16[d]	1	2	0	4	0	4	0	3	0		14[e]	1	15[e]	1	4	1	3	0	4	1	4	0	
Ca (mg)	900	46	937	39	933	50	1668*	41	1231*	80	940	25		661*	36	839	28	960	56	1462*	31	1073[f]	57	795	23	
Vitamin C (mg)	124	15	207[f]	12	255[g]	15	133	7	125	16	102[h]	5		97	8	191*	10	259*	11	108	7	138	17	107	7	
Sociodemographic characteristics by cluster	%		%		%		%		%		%		*P*-value	%		%		%		%		%		%		*P*-value
Age (years)	9·2‡		8·6		8·5		8·6		8·2§		8·5			8·9‖		8·9		8·4		8·4		7·6		8·4		
Ethnicit (non-white)†	22·3		18·1		15·5		16·9		46·2		28·7		0·0003	24·1		14·1		21·6		17·8		28·1		19·4		0·32
Household income level (low)†	14·9		9·6		7·3		7·1		22·0		13·8		0·037	19·2		11·5		14·4		8·8		14·4		9·1		0·21
Food security (insecure)	8·4		13·2		9·0		4·6		8·5		12·0		0·19	10·4		9·0		9·5		3·1		6·5		8·3		0·24
Household education (secondary or lower)	19·0		15·1		19·9		13·7		20·8		18·3		0·78	18·4		22·3		19·4		13·6		30·5		20·6		0·18

%E, percentage of energy; SSB, sugar-sweetened beverages.
Mean values within rows with unlike superscript letters were significantly different from the [a]moderate cluster; [b]fruit drink cluster; [c]soft drink cluster; [d]all except the soft drink cluster; [e]high-fat milk, milk, moderate and fruit juice clusters; [f]all except the fruit juice cluster; [g]all except the fruit drink cluster; and [h]fruit drink, fruit juice and milk clusters within the same sex.
*Significantly different from all clusters within the same sex.
†Significantly different across clusters using Pearson's χ^2 test among boys ($P < 0·05$).
‡Significantly older than the milk cluster within the same sex ($P < 0·05$).
§Significantly younger than all except the fruit juice cluster within the same sex ($P < 0·05$).
‖Significantly older than all clusters within the same sex ($P < 0·05$).

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Table 4 Mean intakes of selected beverage groups, selected nutrients and energy, as well as sociodemographic characteristics, by beverage cluster in boys and girls aged 12–18 years

	Boys									Girls								
	Soft drink (*n* 393)		Fruit drink (*n* 351)		Milk (*n* 378)		Moderate (*n* 1133)			Soft drink (*n* 255)		Fruit drink (*n* 350)		Milk (*n* 405)		Moderate (*n* 1010)		
	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM		Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	
Beverage intake by cluster (g)																		
Fruit drink	151	25	994*	35	143	20	103	7		87	13	829*	37	127	16	91	7	
Soft drink	1059*	29	131	19	174	17	146	10		786*	39	103	17	63	11	86	8	
Milk	233	23	277	21	1116*	37	233	10		144	15	184[a]	17	836*	35	133	8	
High-fat milk	51	13	52	11	63	18	75	10		55	14	54	23	64	14	65	8	
Fruit juice	89[a]	17	143	33	146	20	204	16		98	19	77	15	130	17	221*	15	
Water	563[a]	48	726	61	703	69	808	43		459[a]	57	627	51	582[a]	47	775	43	
Total beverage intake	2339	69	2489	93	2460	84	1782*	50		1804	85	2056[a]	81	1928[a]	65	1615	50	
Nutrient and energy intakes by cluster																		
%E from beverages	27	1	27	1	29	1	17*	1		24	1	27	1	26	1	17*	1	
%E from SSB	18[ab]	1	17[ab]	1	5	0	5	0		16[ab]	1	18[ab]	1	4	0	4	0	
Ca (mg)	1095	43	1203	39	2103*	53	1099	30		808	46	904	35	1705*	74	848	23	
Vitamin C (mg)	114	8	286*	19	148	11	150	7		115[a]	12	223*	12	138	8	156	6	
Sociodemographic characteristics by cluster	%		%		%		%		*P* value	%		%		%		%		*P* value
Age (years)	15·2‡		14·4		14·5		14·6			15·2		14·6		14·7		14·9		
Ethnicity (non-white)†	9·7		13·3		12·8		20·7		0·0036	16·9		10·0		9·1		18·2		0·0224
Household income level (low)	13·7		12·4		3·4		9·8		0·06	15·4		8·3		7·9		9·5		0·29
Food security (insecure)†	4·6		9·3		2·7		9·1		0·0379	13·7		6·6		2·3		6·1		0·0053
Household educational level (secondary or lower)	22·9		19·2		13·6		16·7		0·21	21·6		15·6		12·9		14·7		0·23

%E, percentage of energy; SSB, sugar-sweetened beverages.
Mean values within rows with unlike superscript letters were significantly different from the [a]moderate cluster and [b]milk cluster within the same sex.
*Significantly different from all other clusters.
†Significantly different across clusters using Pearson's χ^2 test ($P < 0·05$).
‡Significantly older than all other clusters within the same sex ($P < 0·05$).

cluster drank >1000g of soft drinks, and they drank significantly less fruit juice and water compared with boys in the ‘moderate’ cluster. Adolescent boys in the ‘fruit drink’ cluster drank the same amount of fruit juice as boys in the ‘milk’ cluster. Adolescent girls aged 12–18 years who were in the ‘fruit drink’ cluster drank significantly less milk compared with girls in the ‘moderate’ and ‘milk’ clusters, but not less than those in the ‘soft drink’ cluster. Girls in the ‘moderate’ cluster had the highest intake of fruit juice compared with all other clusters.

Nutrient and energy intakes by cluster

Within clusters we analysed both energy and selected key nutrients in beverages: percentage of energy from beverages, percentage of energy from sugar-sweetened beverages and percentage of energy from nutrient-based beverages and intakes of Ca and vitamin C.

Children aged 2–5 years consumed between 18 % (‘moderate’ cluster) and 34 % of energy from beverages (‘high-fat milk’ cluster; Table 2). Sugar-sweetened beverages contributed 16 % of total energy intake among those children in the ‘fruit drink’ cluster. Children aged 2–5 years in the ‘milk’ cluster and ‘high-fat milk’ cluster had higher Ca intake compared with all other clusters, although the intakes of the two milk clusters were not significantly different from each other. The ‘fruit juice’ and ‘fruit drink’ clusters had the highest intakes of vitamin C compared with all other clusters. Children in the ‘fruit juice’ cluster had significantly more vitamin C intake compared with those in the ‘fruit drink’ cluster.

Among children aged 6–11 years, percentage of energy from beverages was lowest among those in the ‘moderate’ clusters, at 15 % and 13 %, respectively (Table 3). Those in the ‘high-fat milk’ clusters had the highest percentage of energy from beverages: 28 % for both boys and girls. The percentage of energy from sugar-sweetened beverages was highest among those in the ‘fruit drink’ and ‘soft drink’ clusters. Among children aged 6–11 years, the total Ca intake was highest among boys in the ‘milk’ and ‘high-fat milk’ clusters. Girls in the ‘milk’ cluster had the highest total Ca intake, whereas girls in the ‘soft drink’ cluster has the lowest total Ca intake overall. For both boys and girls, those in the ‘fruit drink’ and ‘fruit juice’ clusters had the highest intakes of total vitamin C compared with other clusters.

The percentage of energy from beverages for adolescent boys aged 12–18 years was 17 % among those in the ‘moderate’ cluster and 29 % among those in the ‘milk’ cluster (Table 4). For girls aged 12–18 years, the percentage of energy from beverages was 17 % among those in the ‘moderate’ cluster and 27 % among those in the ‘fruit drink’ cluster. Percentage of energy from sugar-sweetened beverages was highest among those in the ‘fruit drink’ and ‘soft drink’ clusters (Table 4). Among 12–18-year-old boys, all clusters showed a mean Ca intake from food of >1000 mg/d, although the boys in the ‘milk’ cluster had significantly higher intake of Ca compared with those in other clusters. Boys in the ‘fruit drink’ cluster had significantly higher vitamin C intake compared with boys in other clusters. Adolescent girls aged 12–18 years who were in the ‘fruit drink’ cluster had significantly more vitamin C intake compared with all other clusters. Children in the ‘milk’ cluster had the highest intake of Ca compared with all other clusters.

Sociodemographic characteristics by cluster

Age was significantly different across clusters, except among adolescent girls aged 12–18 years (Tables 2–4). Among 2–5-year-olds, those in the ‘high-fat milk’ cluster were significantly younger than those in the ‘juice’ cluster, but not younger than those in other clusters. Boys aged 6–11 years who drank mostly high-fat milk were significantly younger than those in other clusters, but not younger than those in the ‘juice’ cluster. Girls aged 6–11 years and boys aged 12–18 years who were in ‘soft drink’ clusters were older than children in all other clusters of the same age–sex group. Boys aged 6–11 years who drank mostly soft drinks were older than boys of the same age who were in the ‘moderate’ cluster.

Ethnicity was significantly different across clusters for all age groups, except among girls aged 6–11 years (Tables 2–4). Household income was only significantly different across clusters for boys aged 6–11 years ($P = 0{\cdot}037$). Food security was significantly different across clusters for adolescent boys ($P = 0{\cdot}038$) and girls ($P = 0{\cdot}005$). Household education did not differ across clusters for any age–sex group. Data related to physical activity and body weight by cluster will be provided in a separate publication.

Discussion

Cluster analysis is a data-driven method that categorizes individuals into non-overlapping groups. It identifies groups on the basis of food or beverage intake patterns that can be meaningful and interpretable[16] and goes beyond descriptive analysis of beverage intake. Cluster analysis has been reproduced across populations[16] and has been reproduced for beverage intake among American children[13]. We now report clustering of beverage intakes in Canadian children.

Our results showed clustering patterns similar to those reported by LaRowe *et al.*[13] for 2–5- and 6–11-year-olds, despite slightly different beverage categories used to establish clusters. This may indicate reliability of the clustering process to examine beverage patterns among children. Similarly, the results of the present study were comparable to those found by LaRowe *et al.*[13]. Specifically, percentage of energy intake from beverages and total beverage intakes were comparable between Canadian and American children.

Other studies have examined beverage intake among children and adolescents. Garriguet[17], using CCHS 2·2

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data, found that boys and girls aged 1–3 years consumed 28 % and 27 % of their energy from beverages, respectively, whereas boys and girls aged 4–8 years consumed 21 % and 18 % energy from beverages, respectively. In the same study, adolescents aged 9–13 years consumed 18 % of energy from beverages and 14–18-year-old boys and girls consumed 20 % and 19 %, respectively[17]. Using age categories different from those used by Garriguet[17], we also found that 13–34 % of energy was from beverages, with the lowest percentage of energy being found among the 'moderate' clusters. The percentage of energy from sugar-sweetened beverages was higher among children in the 'fruit drink' and 'soft drink' clusters; children in these clusters are expected to consume high amounts of sweetened beverages and lower amounts of other energy-containing beverages.

In the USA, beverage intakes from the National Health and Nutrition Examination Survey (NHANES) 2005–2006 data showed that children aged 2–6, 7–12 and 13–18 years consumed 1075 ml, 1296 ml and 1927 ml, respectively[6]. Cluster analysis groups beverage consumption by type as well as by volume, thus identifying low and high patterns of beverage consumption. Our results show the ranges of total beverages consumed, which include the mean values by age for American children in 2005–2006, possibly indicating similar beverage consumption levels.

In Canada, sweetened beverage intake is a common pattern among children and adolescents aged 2–18 years. Pre-school-aged children in the fruit drink cluster consumed >500 g of fruit drink per day. Among boys aged 12–18 years in the soft drink cluster, a mean intake of >1000 g of soft drink was determined. These values are far above the recommendations set by US expert panels, which recommend limiting sweetened beverages to <225 g for adults[1], and hence may pose health risks including obesity[18–20] and others[21]. Among American children aged 7–12 and 13–18 years in 2005–2006, the second most consumed beverage after water was soda/soft drinks (342 ml and 606 ml, respectively), followed by whole-fat milk (203 ml and 108 ml, respectively) and juice (79 ml and 107 ml, respectively)[6]. Longitudinal data from adolescents in Germany showed carbonated and uncarbonated sweetened beverage consumption to be 371 g for boys and 245 g for girls[20], levels lower than those in Canada or in the USA. This may be because of differences in study design and beverage grouping, or it may indicate higher sweetened beverage consumption in North America.

High intakes of sweetened beverages have also been associated with low intakes of other nutrients and low overall diet quality[22]. The current results show that young girls (aged 6–11 years) who drink mostly soft drinks have a significantly lower intake of Ca compared with all other clusters (661 mg/d). The Dietary Reference Intake values set by the Institute of Medicine include an Estimated Average Requirement (EAR) for Ca at 500 mg for children aged 1–3 years, 800 mg for those aged 4–8 years and 1100 mg for those aged 9–18 years[23]. Other researchers have found that young girls who consume soft drinks may be at risk for low Ca intake[24] and for low bone mineral content[25].

Vitamin C is a key nutrient found in fruit juices and is often added to fruit drinks. Our results show that vitamin C intakes are above recommendations for all age–sex groups, regardless of cluster. The EAR for vitamin C is 13 mg for children aged 1–3 years, 22 mg for those aged 4–8 years, 39 mg for those aged 9–13 years, 63 mg for adolescent boys aged 14–18 years and 56 mg for adolescent girls aged 14–18 years[26]. Children and adolescents in the 'fruit drink' and 'fruit juice' clusters had higher intakes of vitamin C compared with those in other clusters within the same age–sex groups. Among all cluster solutions, children and adolescents who consumed mostly fruit drinks had a lower intake of fruit juice and vice versa.

Data from the 2005–2006 NHANES indicated water as the most consumed beverage for 2–6-, 7–12- and 13–18-year-olds at 325 ml, 509 ml and 773 ml, respectively[6]. Similarly, our clustered data show that water was the most or second most consumed beverage within the cluster. Water consumption was also high in beverage clusters for 2–5- and 6–11-year-olds using US NHANES data[13]. Water consumption is encouraged in Canada as water is an energy-free beverage[3]. When developing nutritional policy, supporting and enhancing current water consumption by encouraging replacement of sweetened beverages should be encouraged, as excess consumption is rare in normal circumstances[27].

By clustering data on beverage intake, we were able to examine the sociodemographic characteristics of children within beverage clusters. LaRowe *et al.*[13] also examined selected sociodemographic characteristics across beverage clusters and also found that age, ethnicity and household income differed across clusters for children aged 2–5 and 6–11 years.

The present study has some important limitations. First, it is a cross-sectional study; therefore, we cannot determine temporality. Second, dietary information is presented here on the basis of one 24 h recall, which may result in misclassification. The AMPM is used to collect dietary information and has been reported to be accurate, especially among normal-weight individuals[28]. The AMPM attempts to reduce misclassification in the collection of detailed food and beverage information; however, some participants may incorrectly identify fruit beverage as fruit juice and vice versa. It is important to note that the mean value from 1 d intake is similar to that of the adjusted 2 d intake; only variation is reduced when data from 2 d intake are used and adjusted[10]. Finally, cluster analysis is a data-driven method that required decisions and interpretations at various stages. We have documented how each decision was made and have made efforts to offer the most logical interpretations of the data. Despite its limitations, cluster analysis provides interpretable groups of children on the basis of their beverage intake, which goes beyond the

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traditional analysis of examining the mean intake. Cluster analysis allowed us to classify children into sufficiently large groups to assess group-level beverage intakes and sociodemographic factors.

Conclusion

Longitudinal data on beverage intake of Canadian children are needed. In the meantime, determining beverage intake patterns can help to understand the characteristics of high consumers of sweetened beverages. This information supports public health nutrition professionals to target intervention programmes and policies to decrease consumption of sweetened beverages.

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