

# Fruit Drink Consumption Is Associated With Overweight and Obesity in Canadian Women

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## ABSTRACT

**Objective:** Overweight and obesity in Canada have significantly increased during the last three decades, paralleled by increased intake of fat and sugar, particularly sugary beverages. The Canadian Community Health Survey, Cycle 2.2, conducted in 2004 (CCHS 2.2), provides the opportunity to evaluate beverage intakes in relation to overweight and obesity using body mass index (BMI). Our objective was to examine the association between sugar-sweetened beverages and BMI in Canadian adults.

**Methods:** CCHS 2.2 data were used (n=14,304, aged >18 years and ≤65 years) and dietary intake was assessed on the basis of single 24-hour recall. Using cluster analysis (K-means method), males and females were classified into distinct clusters based on the dominant pattern of beverage intakes. Logistic regression models were used to determine associations between dominant beverage consumption patterns and BMI, controlling for age and other confounding factors.

**Results:** BMI in women with predominant "fruit drink" pattern ( $28.3 \pm 1.0$  kg/m<sup>2</sup>) was higher than in those with no dominant pattern ( $26.8 \pm 0.3$  kg/m<sup>2</sup>),  $p < 0.001$ . Adjusting for energy intake and other potential confounders, high intake of fruit drinks was a significant predictor of overweight (OR=1.84, 95% CI: 1.06-3.20), obesity (OR=2.55, 95% CI: 1.46-4.47) and overweight/obesity (OR=2.05, 95% CI: 1.29-3.25) in women. In men, mean BMI was not different among beverage consumption clusters and none of the beverage intake patterns was a predictor for overweight and obesity.

**Conclusion:** Using a nationally representative dataset, there was an association between sugar-sweetened beverages and overweight and obesity in Canadian women.

**Key words:** Obesity; overweight; beverages; women

La traduction du résumé se trouve à la fin de l'article.

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The upward trend of overweight and obesity and associated risks (i.e., cardiovascular diseases, Type 2 diabetes, osteoarthritis, gallbladder disease, some cancers, and premature death)<sup>1-4</sup> has been paralleled by a global change in dietary patterns leading to higher levels of energy intake, as well as by a notable reduction in levels of physical activity.<sup>5</sup> The increase in energy intake is mostly from higher dietary fat and sugar intakes. In the United States, 15-25% of average daily total energy intake of adults is derived from beverages.<sup>6</sup> Further, the consumption of sugar-sweetened beverages (SSB) has increased over the past 20 years, to the point that SSB has become the largest source of beverage calories for American adults today.<sup>7</sup>

Concomitant increases in the consumption of SSB and obesity rates in the adult population suggest a possible causative association.<sup>6,8,9</sup> Although the relationship between beverage consumption and weight management in children has been addressed frequently in recent literature,<sup>1</sup> studies on the adult population are few. There are no data on Canadian adults with respect to this question.

In Canada, the only available comprehensive nutrition dataset is the Canadian Community Health Survey Cycle 2.2 (CCHS 2.2), conducted in 2004, which provides information on food intake (including beverages) of Canadians, as well as measured weight and height at both national and provincial levels. Descriptive data on beverage consumption of Canadians and patterns of beverage intake of Canadian adults have been analyzed and reported previously.<sup>10</sup> However, to our knowledge, no studies have investigated

the association between sugar-sweetened beverages and overweight and obesity defined by body mass index (BMI) on a national scale.

## METHODS

### Study population

Data from CCHS 2.2 were used. Data on demographics, socioeconomic and health status were gathered by interviews, while height and weight were measured by standardized methods.<sup>11</sup> Additional details on CCHS 2.2 can be found elsewhere.<sup>12,13</sup> From the 35,107 participants in CCHS 2.2, we excluded individuals >65 or <19 years of age, as well as pregnant and breastfeeding women; the resulting population of interest had a sample size of 14,304. Further, we identified and excluded those who had a missing value for energy intake (n=15) and those who reported implausible energy intakes<sup>14</sup> (n=2,478). Analyses were performed on both populations: total (n=14,304) and those with plausible energy intake (n=11,811).

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**Table 1.** Sample Size of Each Sex-population Group, and Amount of Dominant Beverage Intake (in grams) for Each Cluster, Canadian Community Health Survey 2.2\*

	<b>Soft Drink</b>	<b>Fruit Drink</b>	<b>Tea</b>	<b>Coffee</b>	<b>Beer</b>	<b>Plain Milk</b>	<b>Mix†</b>
Total population M (n)	658	482	699	850	907	589	2629
Dominant beverage (g)	1118 ± 30	867 ± 42	763 ± 25	1403 ± 38	1355 ± 41	958 ± 36	–
Total population F (n)	447	411	1182	1212	185	–	4026
Dominant beverage (g)	905 ± 38	791 ± 33	751 ± 18	1096 ± 34	1175 ± 92	–	–
Population with plausible energy intake M (n)	666	–	–	754	887	602	2839
Dominant beverage (g)	1163 ± 32	–	–	1425 ± 35	1422 ± 42	948 ± 35	–
Population with plausible energy intake F (n)	404	363	–	1018	190	726	3362
Dominant beverage (g)	936 ± 34	844 ± 34	–	1089 ± 36	1302 ± 52	730 ± 33	–

\* Details of beverage clusters previously reported (“unpublished observations”).

† Mix beverage clusters by definition do not have a defining beverage, thus only total beverage intake is reported.

M=male, F=female, g=gram.

### Dietary assessment

In CCHS 2.2, dietary information from all subjects was obtained using the automated multiple pass method for 24-hour food recalls, which was repeated in 30% of participants.<sup>12</sup> In this study, we used data only from the first 24-hour recall.

### Body size and covariate measures

Measured height and weight values were used and a new categorical BMI variable was created based on the WHO BMI classifications for overweight and obesity.<sup>15</sup> The portion of the sample classified as underweight was very small (1%), and being irrelevant to our study, was excluded from the analyses. Three categories of “BMI” variable were defined as normal, overweight, and obesity.

### Beverage pattern formation

Beverages consumed were extracted through a multiple-step procedure of detection, classification, coding, merging and correction from the CCHS 2.2 data files. These beverages were categorized based on energy and nutrient content.<sup>16</sup> Beverage weight (in grams) or/and energy (in kcal) was/were used in all analyses.

Canadian adults were classified into distinct groups based on the predominant patterns of beverage intake using cluster analysis, K-means method. Optimal number of clusters was determined using Cubic Clustering Criterion (CCC), Pseudo-F statistic (PFS), and interpretability.<sup>17</sup> For interpretability to be achieved, a clear and unique pattern of intake for each cluster was necessary. Among all cluster set analyses, the cluster with the highest number of participants emerged as a mixed cluster, where no dominant pattern of beverage intake was found. This observation was consistent with other cluster analyses on dietary intake representing the majority of the population who consume a variety of beverages in their diet.<sup>16,18</sup> Details of our approach in cluster analyses are explained elsewhere (“unpublished observations”).

### Statistical analysis

The mean intake and standard error of the mean of each beverage group (grams/day), total beverage consumption (g/d), and the percentage of total energy intake from beverages were calculated in all clusters. The means and frequencies for sample characteristics (e.g., household education, food security, ethnicity, and income) were determined. To test differences across beverage patterns,  $\chi^2$  tests were used for categorical variables, and the investigation of overlapping of 95% confidence intervals was used for continuous variables.

Logistic regression analyses were conducted to evaluate the association between the patterns of beverage consumption in Canadi-

an adults and overweight, obesity and overweight/obesity (defined by BMI) controlling for potential confounders (i.e., age, area of residence, season, ethnicity, marital status, immigration status, smoking habits, food security, energy intake from food, physical activity index, respondent education level, and household income) with outcome variables (i.e., overweight, obesity and overweight/obesity).

These steps were carried out for both sex groups in all participants, and in participants with plausible energy intake. All analyses were weighted and bootstrapped using appropriate weight variables provided by Statistics Canada to obtain estimates at the population level.<sup>13</sup> Results are presented as odds ratios (OR) with 95% confidence intervals (CI). In all analyses, alpha was set at the 0.05 level. A variety of statistical packages were used in different stages of analyses, including SAS version 9.2 (SAS Institute Inc., Cary, NC) for data coding and cluster analyses, STATA version 11 (StataCorp LP, College Station, TX) for advanced statistical modeling, SPSS version 16 (SPSS Inc, Chicago, IL) for data coding and creating new variables, and Microsoft Excel 2007 (Microsoft Corporation, Redman, WA) for data coding.

### RESULTS

In total male population (n=6,814) and in total female population (n=7,463), a seven-cluster solution and a six-cluster solution, respectively, were determined to be most appropriate. For male population with plausible energy intake (n=5,748) and for female population with plausible energy intake (n=6,063), a five-cluster solution and a six-cluster solution, respectively, were determined to be most appropriate. The beverage clusters were named using the predominant beverage in corresponding cluster. The number of subjects in each clustering solution as well as the intake of the cluster-defining beverage are presented in Table 1.

In men, BMI ranged from 26.4 ± 0.4 kg/m<sup>2</sup> in the fruit drink cluster to 27.7 ± 0.4 kg/m<sup>2</sup> in milk and tea clusters. In women, BMI ranged from 26.1 ± 0.4 kg/m<sup>2</sup> in the tea drinker cluster to 28.3 ± 1 kg/m<sup>2</sup> in the fruit drink cluster, significantly higher than the tea drinker group (p<0.05). BMI categories of patterns of beverage intake across clusters in men and women are presented in Table 2.

### Logistic regression analysis

Logistic regression models were used to evaluate the association between patterns of beverage consumption with overweight, obesity, and overweight/obesity, adjusting for possible confounders, including: age, area of residence, season, ethnicity, marital status, immigration status, smoking habits, food security, total energy

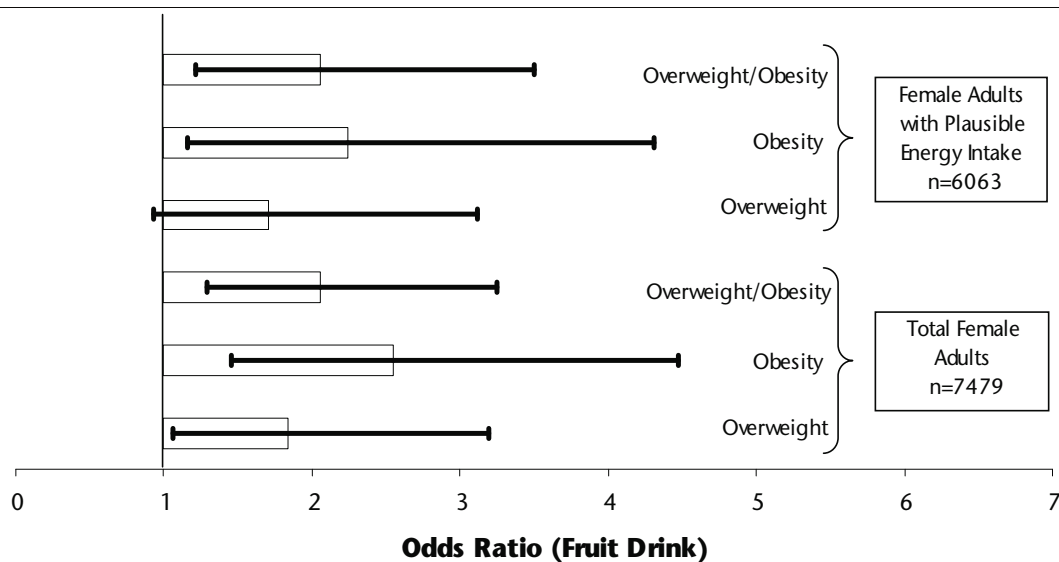
**Table 2.** BMI of Each Beverage Pattern Among Canadian Adults by Sex\*

		Soft Drink	Fruit Drink	Tea	Coffee	Beer	Plain Milk	Mix	P-value
Total Population Male	BMI (mean ± SEM)	26.5±0.4	26.4±0.4	27.7±0.4	27.5±0.5	27±0.4	27.7±0.4	27.3±0.2	0.026
BMI Categories	Normal	39.8	35.8	30.5	28.3	37.1	32.0	35.5	0.43
	Overweight	38.2	48.9	40.9	48.6	42.2	42.2	39.6	
	Obese	22.0	15.3	28.6	23.1	20.7	25.8	24.9	
Total Population Female	BMI (mean ± SEM)	27.2±0.8‡	28.3±1†	26.1±0.4	27.1±0.3‡	27.4±1.8‡	–	26.8±0.3	0.0002
BMI Categories	Normal	43.7	37.1	51.4	45.0	49.0	–	45.7	0.0004
	Overweight	24.0	31.0	24.3	26.7	27.7	–	32.3	
	Obese	32.3	31.9	24.3	28.3	23.3	–	22.0	

\* Detailed characteristics of beverage clusters previously reported (“unpublished observations”).

† Significantly different compared to other groups (except for groups with ‡ superscript).  
SEM=standard error of the mean.

**Figure 1.** A summary of adjusted odds ratio for dominant pattern of fruit drink (compared with moderate intake of all beverages) as a predictor for overweight and/or obesity in Canadian women



intake, physical activity index, respondent education level, and household income. In both populations of men, no beverage clusters remained significant after adjusting for potential confounders. Women with dominant pattern of fruit drinks had significantly higher odds for overweight (OR=1.84, 95% CI: 1.06-3.20, p=0.031), obesity (OR=2.55, 95% CI: 1.46-4.47, p=0.001), and overweight/obesity (OR=2.05, 95% CI: 1.29-3.25, p=0.002), compared with women with no dominant beverage intake. A subgroup of women with plausible energy intake whose dominant beverage pattern was fruit drinks had higher odds for obesity (OR=2.24, 95% CI: 1.17-4.31, p=0.016), and overweight/obesity (OR=2.06, 95% CI: 1.21-3.50, p=0.007), compared with women with no dominant beverage intake (Figure 1).

**DISCUSSION**

In our study, among six beverage clusters in women, BMI of fruit drink consumers was significantly higher than BMI in tea drinker and mix groups. Further, to evaluate the relationship between beverage patterns and overweight/obesity in women, results from logistic regression showed that, adjusting for total energy intake and other potential confounders, those whose dominant beverage intake was fruit drink were 84% more likely to be overweight, 2.55 times more likely to be obese, and 2.05 times more likely to be overweight/obese compared with those who drank a combination

of beverages. In subanalyses excluding participants with implausible energy intake, fruit drink was a significant predictor for obesity and for overweight/obesity. In men, none of the beverage clusters were significant predictors of overweight and obesity.

Several studies suggest that sugar-sweetened fruit drinks contribute to overweight and obesity because of excess calorie intake that offers low satiety.<sup>19,20</sup> However, short-term studies in humans<sup>21,22</sup> and experimental studies in animals<sup>23</sup> show that this extra energy provided by sugar-sweetened beverages does not affect subsequent food and energy intake from solid foods.<sup>24</sup> Liebman et al.<sup>25</sup> state that men may be better able to maintain caloric balance, even with the higher energy intakes associated with the consumption of larger beverage sizes. This might explain why there was no positive association of fruit drink pattern and overweight/obesity in men.

Our findings are similar to evidence from other cross-sectional studies on adults,<sup>25,26</sup> showing a strong positive relationship between sugar-sweetened beverages and BMI, and obesity in female but not male subpopulation. The comprehensive data on dietary intake as well as cluster analyses allowed us to determine the type of sugar-sweetened beverage, i.e., “fruit drink”, associated with risk of overweight and obesity and subpopulation with dominant intake of fruit drinks. We also considered the impact of under-reporting the energy intake by excluding participants with implau-

sible energy intake. Moreover, our study had a considerably larger number of participants, representative of the Canadian population, with CCHS-measured height and weight, while other studies were based on data from self-reported or self-measured height and weight.

Our study, like other studies that used large survey data, has some limitations due to the study design with regard to survey data and analytical approaches. Cross-sectional data do not allow us to determine the temporal relationship between beverage intake and adults' weight. In general, using survey data such as CCHS may restrict investigation into other factors that may impact the relationship. However, in our statistical models, we controlled for all potential confounders that might affect the relationship between patterns of beverage intake and BMI. The positive association between obesity, overweight/obesity and dominant pattern of fruit drink intake after adjusting for total energy intake and excluding implausible energy intake supports the notion that this association is not mediated through energy intake.

Data from a single 24-hour recall does not reflect day-to-day variation in usual pattern of dietary intake at the individual level; however, when the purpose is assessing dietary intakes at the population level, the mean intake from one day provides an estimate of the usual intake for the population.<sup>11</sup> Further, we determined the best cluster solution by plotting Pseudo-F statistics and CCC, and identifying meaningful emerging beverage consumption patterns that are interpretable both statistically and in the light of most recent literature. In addition, the large sample size (n=14,304) allowed us to identify discrete beverage patterns, and it was less likely to commit type II error by narrowing confidence intervals. Hence, such an approach is more comprehensive in identifying patterns of beverage consumption in a population compared to regular analysis where only mean intake of beverages is determined.

In conclusion, evidence from other studies indicates considerable increase in consumption of sugar-sweetened beverages globally. This is the first study that reports that Canadian women with dominant pattern of sugar-sweetened beverages, mainly from fruit drinks, are more at risk of overweight and/or obesity compared to those who have a relatively moderate intake of all beverages. The presence of positive association between fruit drink and overweight/obesity after controlling for potential mediators in a nationally representative sample indicates the importance of our findings. Most obesity-prevention policies have targeted carbonated soft drinks and focused mainly on children. Our finding indicates that fruit drinks, as another type of sugar-sweetened beverage, raise similar health concerns in adult women.

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## RÉSUMÉ

**Objectif :** Le surpoids et l'obésité ont beaucoup augmenté au Canada au cours des 30 dernières années, parallèlement à la consommation accrue de gras et de sucre, en particulier les boissons sucrées. L'Enquête sur la santé dans les collectivités canadiennes, cycle 2.2, menée en 2004 (ESCC 2.2) permet d'évaluer la consommation de boissons par rapport au surpoids et à l'obésité à l'aide de l'indice de masse corporelle (IMC). Notre objectif était d'examiner l'association entre les boissons édulcorées au sucre et l'IMC chez les Canadiens et Canadiennes adultes.

**Méthode :** Nous avons utilisé les données de l'ESCC 2.2 (n=14 304, >18 ans à ≤65 ans); l'apport alimentaire a été évalué à l'aide d'une seule feuille de rappel des aliments ingérés pendant les 24 dernières heures. À l'aide d'une analyse en grappes (méthode à K moyennes), hommes et

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femmes ont été classés dans des grappes distinctes d'après leur profil dominant de consommation de boissons. En utilisant des modèles de régression logistique, nous avons calculé les associations entre les profils dominants de consommation de boissons et l'IMC, après avoir apporté des ajustements pour tenir compte des effets de l'âge et d'autres facteurs de confusion.

**Résultats :** L'IMC des femmes ayant un profil prédominant de consommation de « boissons aux fruits » ( $28,3 \pm 1,0 \text{ kg/m}^2$ ) était plus élevé que chez celles qui ne présentaient pas de profil dominant ( $26,8 \pm 0,3 \text{ kg/m}^2$ ),  $p < 0,001$ . En tenant compte de l'apport énergétique et d'autres facteurs de confusion possibles, une consommation élevée de boissons aux fruits était un prédicteur significatif de surpoids (RC=1,84, IC de 95 % : 1,06-3,20), d'obésité (RC=2,55, IC de 95 % : 1,46-4,47) et de surpoids/obésité (RC=2,05, IC de 95 % : 1,29-3,25) chez les femmes. Chez les hommes, l'IMC moyen n'était pas différent d'une grappe de consommation de boissons à l'autre, et aucun profil de consommation de boissons n'était un prédicteur de surpoids et d'obésité.

**Conclusion :** En utilisant un fichier représentatif à l'échelle du pays, nous observons une association entre la consommation de boissons édulcorées au sucre et le surpoids et l'obésité chez les Canadiennes.

**Mots clés :** obésité; surpoids; boissons; femmes



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