



## Clinical Research

# Poor Adherence to Dietary Guidelines Among French-Speaking Adults in the Province of Quebec, Canada: The PREDISE Study

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*See editorial by Brophy, pages 1551–1552 of this issue.*

## ABSTRACT

**Background:** Regular monitoring of the population's food and nutrient intake is essential to develop effective nutrition-focused public health policies. The aim of this study was to provide dietary intake estimates using an age- and sex-representative sample of French-speaking adults with Internet access from 5 administrative regions in the province of Quebec, Canada.

**Methods:** PRÉDICTeurs Individuels, Sociaux et Environnementaux (PREDISE) is a multicentre cross-sectional study that used a Web-based approach to collect individual, social, and environmental data on factors associated with adherence to dietary recommendations. Dietary intake was estimated from the average of 3 validated Web-based 24-hour recalls.

## RÉSUMÉ

**Contexte :** La surveillance régulière des apports alimentaires et nutritionnels au sein de la population est indispensable pour élaborer des politiques de santé publique efficaces en matière de nutrition. L'objectif de cette étude était de présenter des estimations des apports alimentaires dans un échantillon représentatif sur le plan de l'âge et du sexe d'adultes francophones de cinq régions administratives de la province du Québec (Canada) qui avaient accès à Internet. **Méthodologie :** L'étude PREDISE (Prédicteurs Individuels, Sociaux et Environnementaux) est une étude transversale multicentrique qui visait à recueillir au moyen d'une plateforme Web des données de nature individuelle, sociale et environnementale sur des facteurs associés à l'adhésion aux recommandations sur la saine alimentation.

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See page 1672 for disclosure information.

Unhealthy dietary habits have been identified as the second leading risk factor for mortality globally.<sup>1</sup> Data also suggest that more than 50% of global deaths attributable to unhealthy dietary habits are due to cardiovascular diseases.<sup>1</sup> These observations emphasize the need for more effective public health actions aimed at improving dietary habits of Canadians, because heart diseases remain one of the leading causes of death in Canada.<sup>2</sup>

**Results:** Mean ( $\pm$  SD) age of the 1147 participants (50.2% women) was  $43.2 \pm 4.6$  years and median body mass index was 26.3 (interquartile range, 23.3-30.3). Less than 25% of participants met Canada's Food Guide recommendations for vegetables and fruit intake (prevalence, 23.6%; 95% confidence interval [CI], 21.1-26.0). Most participants reported consuming more than 2300 mg of sodium (prevalence, 80.5%; 95% CI, 78.2-82.7) and more than 10% energy as saturated fats (prevalence, 74.2%; 95% CI, 71.6-76.7). Mean Canadian Healthy Eating Index score on a scale of 0-100 was 54.5 (95% CI, 53.8-55.2), reflecting relatively poor diet quality according to current dietary recommendations.

**Conclusions:** Self-reported dietary intakes measured using a new validated Web-based 24-hour recall in this sample of French-speaking adults from Quebec and with access to Internet suggest low adherence to current Canadian dietary guidelines. These data emphasize the need for more effective nutrition-focused public health policies to maximize cardiovascular disease prevention at the population level.

Knowledge of the population's dietary intake is crucial to inform public health policies and actions.<sup>3</sup> The last comprehensive analysis of dietary intake data in Canada was on the basis of information from the Canadian Community Health Survey (CCHS) Cycle 2.2 conducted in 2004, because results from the CCHS 2015, the most recent health survey in Canada, have yet to be published. CCHS 2004 data in adults from Québec indicated that one-third of participants consumed < 5 servings per day of vegetables and fruit (V&F) and close to two-thirds of participants consumed < 2 servings per day of milk products and alternatives.<sup>4,5</sup> The effect of more recent public health campaigns aimed at improving the dietary habits of the Quebec and Canadian population remains unknown.<sup>6,7</sup>

It is now acknowledged that the use of Web-based tools to monitor dietary habits has the potential to revolutionize national surveys and population studies.<sup>8,9</sup> For example, the use of digital images in Web-based 24-hour recalls might lead to less misestimation of portion size compared with interviewer-administered recalls.<sup>10</sup> We have recently developed and validated a new Web-based 24-hour recall instrument (R24W) that allows rapid and cost-efficient assessment of dietary intake in the population.<sup>11-13</sup> As part of the PRÉdicteurs Individuels, Sociaux et Environnementaux (PREDISÉ) study, we examined current dietary intake of an age- and sex-representative sample of French-speaking adults from 5 administrative regions in the province of Quebec with access to Internet, using the R24W. We also examined the proportion of this population who achieved current Canadian recommendations for key foods and nutrients, namely V&F, sodium, and saturated fats (SFA), and characterized their overall diet quality. The present study provides the most up-to-date and comprehensive data of food and nutrient intake and dietary risk in the Province of Quebec.

Les apports alimentaires ont été estimés à partir de la moyenne de trois rappels alimentaires de 24 heures sur plateforme Web validés.

**Résultats :** L'âge moyen ( $\pm$  ET) des 1147 participants (dont 50,2 % de femmes) était de  $43,2 \pm 4,6$  ans, et leur indice de masse corporelle médian était de 26,3 (intervalle interquartile : 23,3-30,3). Moins de 25 % des participants suivaient les recommandations du *Guide alimentaire canadien* en ce qui concerne la consommation de légumes et de fruits (prévalence : 23,6 %; intervalle de confiance [IC] à 95 % : 21,1-26,0). La plupart des participants ont déclaré consommer plus de 2300 mg de sodium (prévalence : 80,5 %; IC à 95 % : 78,2-82,7) et obtenir plus de 10 % de leur énergie sous forme de gras saturés (prévalence : 74,2 %; IC à 95 % : 71,6-76,7). L'indice canadien moyen de saine alimentation était de 54,5 sur une échelle allant de 0 à 100 (IC à 95 % : 53,8-55,2), ce qui dénote un régime alimentaire de qualité relativement médiocre par rapport aux recommandations actuelles en la matière.

**Conclusions :** Les apports alimentaires autodéclarés mesurés à l'aide d'une nouvelle méthode de rappels de 24 heures sur plateforme Web validés dans cet échantillon d'adultes francophones du Québec ayant accès à Internet font ressortir une faible adhésion aux recommandations canadiennes en matière de nutrition. Ces données mettent en lumière la nécessité d'élaborer des politiques de santé publique en matière de nutrition plus efficaces afin de maximiser la prévention des maladies cardiovasculaires dans la population.

## Methods

### Study design and participants

Data for this analysis were collected in the context of the PREDISÉ study, a Web-based study designed to assess the association between individual, social, and environmental factors, and adherence to current dietary guidelines in Canada. PREDISÉ is a multicenter cross-sectional study involving 5 research centres located in 5 different administrative regions in the province of Quebec, Canada: Capitale-Nationale/Chaudière-Appalaches (Institute of Nutrition and Functional Foods, Quebec City), Estrie (Centre Hospitalier Universitaire de Sherbrooke, Sherbrooke), Mauricie (Clinique multidisciplinaire en santé, Université du Québec à Trois-Rivières, Trois-Rivières), Montreal (Montreal Clinical Research Institute, Montreal), and Saguenay-Lac-St-Jean (ECOGENE-21 Biocluster, Saguenay). Recruitment took place between August 2015 and April 2017 and aimed for a sample size of 1000 participants. To be eligible, participants had to be between 18 and 65 years of age, to speak French as primary language at home, to have a computer, to have access to the Internet, and to have a valid e-mail address. Pregnant and lactating women were not eligible. Thirty strata (Supplemental Table S1) were created on the basis of the 5 administrative regions, sex, and 3 predetermined age groups (18-34, 35-49, and 50-65 years). The sampling in each stratum was proportional to the population of each administrative region according to the most recent demographic data from the Institut de la statistique du Québec (2013). A survey firm recruited participants by selecting phone numbers via random digit dialing until the designated quotas were reached in each stratum. Individuals who agreed to participate in the study received the address of the study Web site to access the consent form and the online study questionnaires. Participants

who completed the study questionnaires were eligible for a draw to win 1 of 40 gift cards and 2 electronic devices. The study protocol was approved by the ethics board from each participating institution.

### Individual, social, and environmental assessment

The participants had a 21-day period to complete 13 on-line questionnaires in random order to assess factors related to eating habits (Supplemental Table S2). Participants who completed all online questionnaires were invited for an in-person visit in their respective research centers for clinical assessment (see the Supplemental Methods section of the Supplementary Material).

### Dietary assessment via Web-based 24-hour recalls

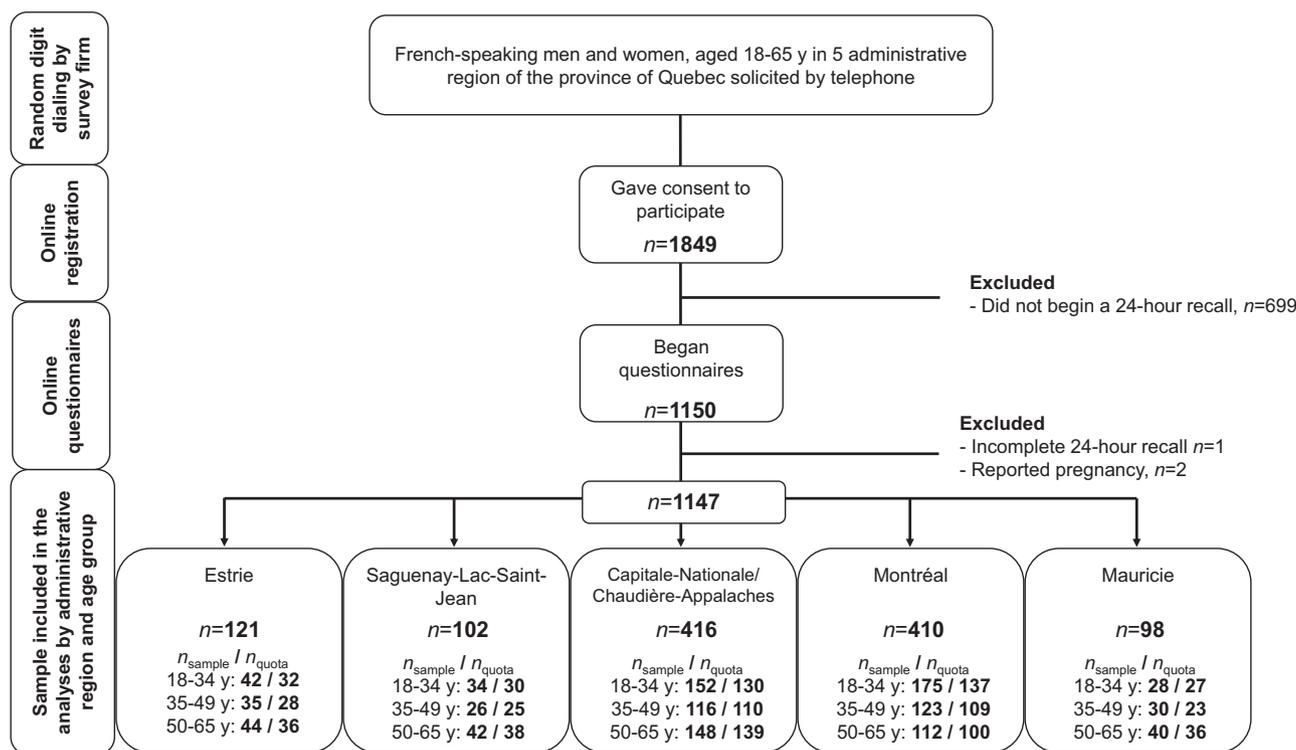
Participants were invited via e-mail and phone call to complete the R24W on 3 unannounced days selected randomly using an in-house computer algorithm. Participants had 24 hours to complete each recall. Details about the development and validation of the R24W have been reported elsewhere.<sup>11-13</sup> Additional information is available in the Supplemental Methods section and in Supplemental Tables S3 and S4 of the Supplementary Material.

The proportion of the population who achieved age- and sex-specific Canada's Food Guide (CFG) 2007 recommendations for V&F, milk and alternatives, and whole grains was estimated.<sup>6</sup> Of note, fruit juices were excluded from the V&F category for calculation of mean intake, but were included in examining prevalence of intake of V&F to reflect current recommendations in Canada.<sup>6</sup> Common thresholds were used

for SFA (ie, 10% of total energy intake)<sup>14</sup> and sodium (ie, the tolerable upper intake level of 2300 mg/d).<sup>15</sup> Diet quality was assessed using the Canadian adaptation of the 2005 American Healthy Eating Index (C-HEI) to reflect current dietary recommendations in Canada (ie, CFG 2007). The C-HEI score was calculated for each R24W completed, as described previously,<sup>16</sup> and the mean C-HEI score from all R24Ws was used in the analyses. Data on dietary supplement usage were not considered in this study.

### Statistical analyses

The statistical software package SAS Studio (version 3.6; SAS Institute, Cary, NC) and survey-specific procedures were used for all analyses. The final PREDISE sample was larger than anticipated and sampling weights were used to ensure age- and sex-representativeness in each region according to recruitment quotas (Supplemental Table S1). Missing socio-demographic characteristics (body mass index [BMI] category, n = 125; education, n = 60; and income level, n = 159) were imputed using the fully efficient fractional imputation method. To account for survey design, a variable representing the 30 sampling strata was included within the STRATA statement in the imputation procedure. Subsequent analyses were performed using the imputed data and the jackknife method for estimating variance, which considered the stratified design, sampling weights, and the imputed data. Potential differences across sociodemographic subgroups were contrasted using PROC SURVEYREG with the Tukey–Kramer adjustment for multiple comparisons. Age group, sex, administrative region, BMI category, household income, and education levels and weekend indicator were added as



**Figure 1.** Participants' flow chart in the **Prédicteurs Individuels, Sociaux et Environnementaux (PREDISE)** study. Sample sizes are unweighted. n<sub>quota</sub>, quota sample size; n<sub>sample</sub>, actual sample size.

**Table 1. Sociodemographic characteristics of the age- and sex-representative 1147 French-speaking adults from 5 administrative regions of the Province of Quebec, Canada**

Characteristic	n (%) [95% CI]
Sex	
Women	576 (50.2)
Men	571 (49.8)
Age group, y	
18-34	408 (35.6)
35-49	338 (29.5)
50-65	400 (34.9)
Administrative region	
Estrie	110 (9.6)
Saguenay-Lac-Saint-Jean	107 (9.3)
Capitale-Nationale/Chaudière-Appalaches	435 (37.9)
Montreal	397 (34.6)
Mauricie	99 (8.6)
Body mass index group*	
Normal (< 25.0)	453 (39.5) [36.5-42.4]
Overweight (25.0-29.9)	383 (33.4) [30.5-36.2]
Obese (≥ 30.0)	312 (27.2) [24.4-29.9]
Ethnicity <sup>†</sup>	
Caucasian	1003 (94.3) [93.0-95.7]
African/African American	25 (2.4) [1.5-3.3]
Hispanic	18 (1.7) [0.9-2.5]
Other	17 (1.6) [0.9-2.4]
Education*	
High school or less	284 (24.8) [22.2-27.3]
CEGEP <sup>‡</sup>	353 (30.7) [28.0-33.5]
University	510 (44.5) [41.6-47.4]
Household income, CAD\$*	
< 30,000	192 (16.8) [14.4-19.1]
30,000 to < 60,000	328 (28.6) [25.8-31.5]
60,000 to < 90,000	227 (19.8) [17.2-22.3]
≥ 90,000	400 (34.9) [31.9-37.8]
Smoking	
Yes	163 (14.2) [12.2-16.2]
Formerly	379 (33.0) [30.4-35.7]
Never	605 (52.8) [49.9-55.6]
Following a particular diet <sup>†</sup>	
No	1025 (89.4) [87.6-91.2]
Weight loss	17 (1.5) [0.8-2.2]
Vegetarian	10 (0.9) [0.4-1.4]
Gluten- or lactose-free	18 (1.6) [0.9-2.3]
Other	76 (6.6) [5.1-8.0]
Level of competence for using a computer or Internet <sup>†</sup>	
Low	79 (7.3) [5.7-8.8]
Medium	405 (37.4) [34.6-40.2]
High	599 (55.3) [52.5-58.1]
24-hour recall completed	
1	28 (2.4) [1.6-3.3]
2	34 (3.0) [2.0-4.0]
3	1085 (94.6) [93.3-95.9]

Frequencies are weighted, and rounding might have caused the sample size to equal 1147 ± 1.

CEGEP, collège d'enseignement général et professionnel; CI, confidence interval.

\* Missing sociodemographic characteristics have been imputed. See the *Methods* section for details.

<sup>†</sup> The numbers in subgroups might not sum to the total number of participants because of missing data. In such cases, data were not imputed.

<sup>‡</sup> CEGEP is a preuniversity and technical college institution specific to the Quebec educational system.

covariates when appropriate. For categorical variables, potential differences were examined with the Rao–Scott modified  $\chi^2$  test in PROC SURVEYFREQ. A 2-sided  $\alpha$  level of 0.05 was used to assess statistical significance.

## Results

### Participants' characteristics

A total of 1849 participants met inclusion criteria and 1147 completed the R24W on at least 1 occasion (Fig. 1). Their characteristics are presented in Table 1. Individuals with a university degree were over-represented compared with the population data (Supplemental Table S1). Mean ( $\pm$  SD) age of the participants was 43.2  $\pm$  4.6 years, and median (interquartile range) BMI was 26.3 (23.3-30.3), with values ranging from 16.3 to 67.7. Characteristics of participants with complete data and participants with incomplete data are presented in Supplemental Table S5.

### Intake of CFG food groups

Table 2 shows mean intake in servings per day of the main food groups in all participants and according to sociodemographic characteristics. Median intake is presented in Supplemental Table S6.

Mean intake of total V&F (excluding fruit juices) in all participants was 4.6 servings per day (95% confidence interval [CI], 4.5-4.8) with similar values between men and women. Consumption of fruit juice was also similar between men and women (median intake, 0.3 and 0.2 servings per day, respectively; Supplemental Table S6). Consumption of V&F was inversely associated with BMI categories and positively with education levels. Less than a quarter of participants achieved the CFG recommended intake for V&F including fruit juice (prevalence, 23.6%; 95% CI, 21.1-26.0%]; Figure 2A).

Mean intake of total grain products in all participants was 5.6 servings per day (95% CI, 5.5-5.8). Men reported consuming more grain, whole grain, and non-whole grain products compared with women. Only 12.9% (95% CI, 10.9-14.8) of participants achieved CFG age- and sex-specific recommended intake for whole grains (not shown).

Mean intake of milk and alternative products in all participants was 2.1 servings per day (95% CI, 2.0-2.2), with < 40% achieving CFG age- and sex-specific recommended servings per day (prevalence, 39.4%; 95% CI, 36.6-42.1; Figure 2B), especially in the older age group (prevalence, 22.9%; 95% CI, 18.7-27.2). Cheese (29.5%), milk (28.8%), and other foods such as prepackaged and mixed meals (21.7%) were the main foods contributing to total intake of milk and alternatives (in servings per day; Figure 3A). Plant-based beverages contributed only 4.0% of daily servings of this food group.

Mean intake of meat and alternatives in all participants was 2.4 servings per day (95% CI, 2.4-2.5). Consumption was greater in men than in women and was positively associated with household income. Red meat (39.5%), legumes, nuts and seeds (21.7%), and poultry (20.9%) were the main foods contributing to total intake of meat and alternatives (Figure 3B).

### Intake of sodium and SFA

A total of 80.5% (95% CI, 78.2-82.7) of participants reported consuming 2300 mg/d or more of sodium (Figure 4A). Prevalence of excess sodium intake was higher in men than in women and was positively associated with household income. Consumption of SFA exceeded 10% energy intake in 74.2%

**Table 2.** Mean intake of Canada's Food Guide food groups in a sample of 1147 French-speaking adults from 5 administrative regions of the Province of Quebec, Canada

Food group	n (weighted)	Servings per day (95% CI)							
		Vegetables and whole fruit	Vegetables	Whole fruits*	Grain products	Whole grain products*	Non-whole grain products	Milk and alternatives	Meat and alternatives
All	1147	4.6 (4.5-4.8)	3.2 (3.1-3.3)	1.4 (1.3-1.5)	5.6 (5.5-5.8)	1.6 (1.5-1.7)	4.1 (4.0-4.2)	2.1 (2.0-2.2)	2.4 (2.4-2.5)
Sex									
Women	576	4.5 (4.2-4.8)	3.1 (2.9-3.3)	1.4 (1.2-1.6)	4.8 (4.5-5.1) <sup>a</sup>	1.3 (1.2-1.5) <sup>a</sup>	3.5 (3.2-3.7) <sup>a</sup>	2.0 (1.9-2.2)	2.1 (2.0-2.2) <sup>a</sup>
Men	571	4.3 (4.0-4.7)	3.1 (2.9-3.3)	1.2 (1.0-1.4)	6.3 (6.0-6.6) <sup>b</sup>	1.6 (1.4-1.8) <sup>b</sup>	4.7 (4.4-5.0) <sup>b</sup>	2.2 (2.0-2.3)	2.8 (2.6-2.9) <sup>b</sup>
<i>P</i>		0.25	0.92	0.10	< 0.0001	0.004	< 0.0001	0.08	< 0.0001
Age group, y									
18-34	408	4.3 (4.0-4.7)	3.1 (2.8-3.3)	1.2 (1.0-1.4)	5.6 (5.3-6.0)	1.2 (1.1-1.4) <sup>a</sup>	4.4 (4.1-4.7) <sup>a</sup>	2.1 (1.9-2.2)	2.5 (2.3-2.6)
35-49	338	4.3 (4.0-4.7)	3.1 (2.8-3.3)	1.3 (1.1-1.5)	5.6 (5.3-6.0)	1.5 (1.3-1.7) <sup>a,b</sup>	4.1 (3.8-4.4) <sup>a</sup>	2.1 (2.0-2.3)	2.5 (2.3-2.6)
50-65	400	4.6 (4.3-5.0)	3.2 (3.0-3.5)	1.4 (1.2-1.6)	5.4 (5.1-5.7)	1.7 (1.5-1.9) <sup>b</sup>	3.7 (3.4-4.0) <sup>b</sup>	2.1 (1.9-2.3)	2.4 (2.3-2.5)
<i>P</i>		0.17	0.37	0.24	0.27	< 0.0001	< 0.0001	0.85	0.49
Administrative region									
Estrie	110	4.5 (4.0-5.1)	3.3 (2.9-3.7)	1.2 (1.0-1.5)	5.5 (5.1-5.9)	1.7 (1.4-2.0)	3.8 (3.4-4.2)	2.0 (1.8-2.3)	2.5 (2.3-2.7)
Saguenay-Lac-Saint-Jean	107	4.1 (3.5-4.6)	2.9 (2.5-3.2)	1.2 (0.9-1.5)	5.7 (5.2-6.1)	1.2 (0.8-1.5)	4.5 (4.1-4.9)	2.3 (2.0-2.6)	2.4 (2.2-2.6)
Capitale-Nationale/Chaudière-Appalaches	435	4.5 (4.2-4.8)	3.1 (2.9-3.3)	1.3 (1.2-1.5)	5.5 (5.2-5.8)	1.5 (1.3-1.6)	4.0 (3.7-4.3)	2.2 (2.0-2.3)	2.5 (2.3-2.6)
Montreal	397	4.7 (4.4-5.0)	3.2 (3.0-3.4)	1.5 (1.3-1.6)	5.8 (5.5-6.1)	1.5 (1.3-1.7)	4.3 (4.0-4.6)	2.0 (1.8-2.1)	2.4 (2.2-2.5)
Mauricie	99	4.4 (3.9-5.0)	3.1 (2.8-3.5)	1.3 (1.0-1.6)	5.3 (4.8-5.7)	1.6 (1.3-1.9)	3.7 (3.2-4.2)	2.1 (1.8-2.3)	2.4 (2.2-2.7)
<i>P</i>		0.23	0.32	0.19	0.16	0.23	0.009 <sup>†</sup>	0.14	0.83
BMI group <sup>‡</sup>									
Normal (< 25.0)	453	4.7 (4.3-5.0) <sup>a</sup>	3.2 (3.0-3.5)	1.4 (1.3-1.6) <sup>a</sup>	5.5 (5.2-5.8)	1.6 (1.4-1.8)	4.0 (3.7-4.3)	2.1 (1.9-2.2)	2.5 (2.3-2.6)
Overweight (25.0-29.9)	383	4.5 (4.2-4.9) <sup>a,b</sup>	3.2 (3.0-3.4)	1.3 (1.1-1.5) <sup>a,b</sup>	5.5 (5.2-5.8)	1.5 (1.3-1.6)	4.1 (3.8-4.4)	2.2 (2.0-2.3)	2.4 (2.3-2.6)
Obese (≥ 30.0)	312	4.1 (3.8-4.5) <sup>b</sup>	3.0 (2.7-3.2)	1.1 (1.0-1.3) <sup>b</sup>	5.6 (5.3-5.9)	1.4 (1.2-1.6)	4.2 (3.8-4.5)	2.1 (1.9-2.2)	2.4 (2.3-2.6)
<i>P</i>		0.01	0.10	0.01	0.95	0.40	0.46	0.61	0.93
Education <sup>‡</sup>									
High school or less	284	4.1 (3.7-4.5) <sup>a</sup>	2.9 (2.6-3.1) <sup>a</sup>	1.2 (1.0-1.4) <sup>a</sup>	5.7 (5.3-6.0)	1.4 (1.2-1.6)	4.3 (3.9-4.6)	2.0 (1.8-2.2) <sup>a</sup>	2.5 (2.3-2.7)
CEGEP <sup>§</sup>	353	4.4 (4.1-4.7) <sup>a</sup>	3.2 (2.9-3.4) <sup>a,b</sup>	1.2 (1.0-1.4) <sup>a</sup>	5.4 (5.1-5.7)	1.4 (1.2-1.6)	4.0 (3.7-4.3)	2.0 (1.8-2.2) <sup>a</sup>	2.5 (2.3-2.6)
University	510	4.9 (4.5-5.2) <sup>b</sup>	3.4 (3.1-3.6) <sup>b</sup>	1.5 (1.3-1.7) <sup>b</sup>	5.6 (5.3-5.9)	1.6 (1.4-1.8)	4.0 (3.7-4.3)	2.3 (2.1-2.5) <sup>b</sup>	2.4 (2.2-2.5)
<i>P</i>		0.001	0.004	0.003	0.40	0.38	0.23	0.001	0.20
Household income, CAD\$ <sup>‡</sup>									
< 30,000	192	4.1 (3.7-4.6)	2.9 (2.6-3.2)	1.2 (1.0-1.4)	5.4 (5.0-5.8)	1.4 (1.2-1.7)	4.0 (3.6-4.4)	2.0 (1.8-2.2)	2.2 (2.0-2.4) <sup>a</sup>
≥ 30,000 to < 60,000	328	4.5 (4.2-4.8)	3.2 (2.9-3.4)	1.3 (1.1-1.5)	5.6 (5.3-5.9)	1.4 (1.2-1.6)	4.2 (3.9-4.5)	2.1 (1.9-2.2)	2.5 (2.3-2.6) <sup>a,b</sup>
≥ 60,000 to < 90,000	227	4.6 (4.1-5.0)	3.2 (2.9-3.5)	1.4 (1.1-1.6)	5.6 (5.2-5.9)	1.6 (1.3-1.8)	4.0 (3.7-4.3)	2.2 (2.0-2.4)	2.5 (2.4-2.7) <sup>b</sup>
≥ 90,000	400	4.6 (4.3-4.9)	3.3 (3.0-3.5)	1.3 (1.2-1.5)	5.6 (5.3-5.9)	1.5 (1.3-1.6)	4.1 (3.8-4.4)	2.1 (2.0-2.3)	2.6 (2.4-2.7) <sup>b</sup>
<i>P</i>		0.22	0.20	0.77	0.90	0.65	0.69	0.72	0.02

All food groups are presented as mean (95% CI) intake in servings per day according to Canada's Food Guide serving sizes. *P* values are the partial effect of the sociodemographic characteristics on intake in the linear model. All subgroup intake estimates are least square means adjusted for age group, sex, administrative region, BMI group, education, household income level, and weekend, when appropriate. Rounding of weighted frequencies might have caused the sample size to equal 1147 ± 1.

BMI, body mass index; CEGEP, collège d'enseignement général et professionnel; CI, confidence interval.

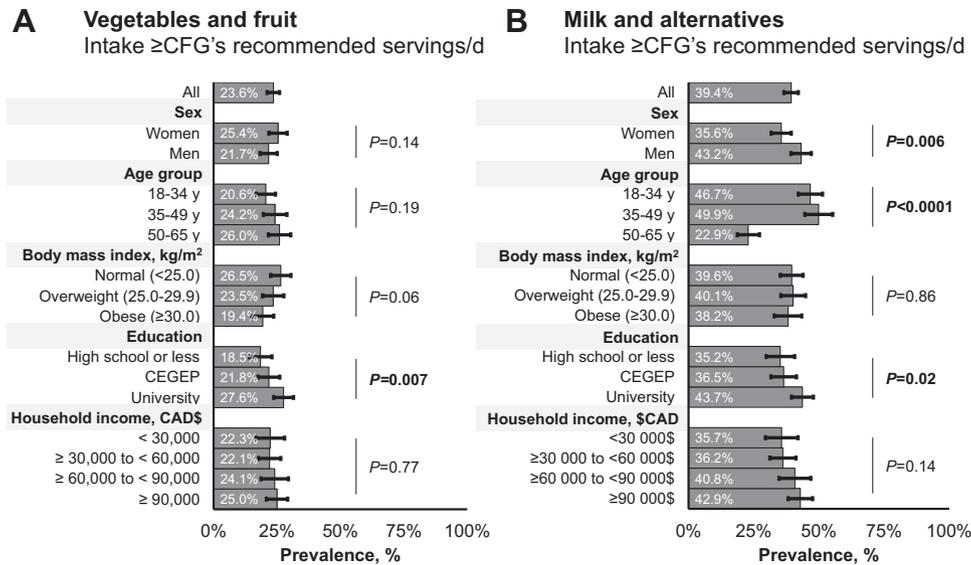
<sup>a,b</sup> Subgroups least square means without a common superscript letter are significantly different (*P* < 0.05, Tukey-Kramer).

\* Due to highly-skewed nature of the variables and multiple zero intake values, using median of intakes is advised (Supplemental Table S6).

<sup>†</sup> Adjustment for multiple comparisons rendered differences among administrative regions statistically nonsignificant.

<sup>‡</sup> Missing sociodemographic characteristics have been imputed. See the *Methods* section for details.

<sup>§</sup> CEGEP is a preuniversity and technical college institution specific to the Quebec educational system.



**Figure 2.** Proportion (95% CI) of individuals consuming ≥ age- and sex-specific Canada Food Guide-recommended intake of (A) vegetables and fruit (including fruit juice) and (B) milk and alternatives, in a sample of 1147 French-speaking adults from 5 administrative regions of the Province of Quebec, Canada. The current recommendation for intake of vegetables and fruits ranges from 7 to 8 servings per day. The current recommendation for intake of milk and alternatives ranges from 2 to 3 servings per day. CEGEP, collège d'enseignement général et professionnel; CFG, Canada's Food Guide; CI, confidence interval.

of participants (95% CI, 71.6-76.7; **Figure 4B**) and showed a positive association with weight status.

**Diet quality**

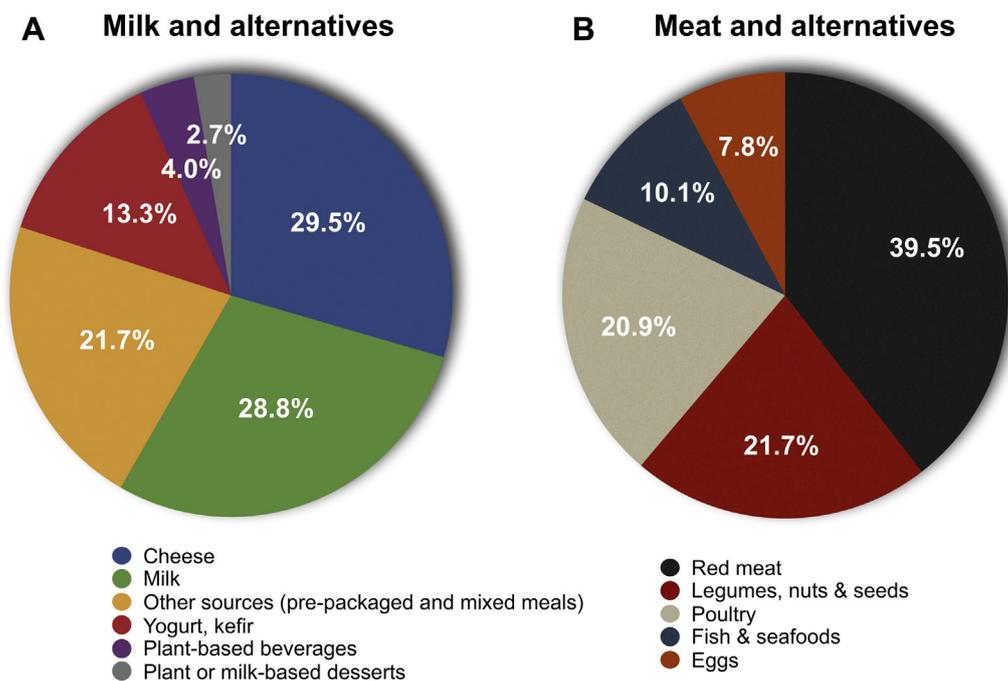
Mean C-HEI score on a scale of 0-100 was 54.5 (95% CI, 53.8-55.2; **Table 3**) with higher scores in women compared with men. Age and education were positively associated with the C-HEI whereas a higher BMI was associated with a lower C-HEI score.

**Nutrient intake**

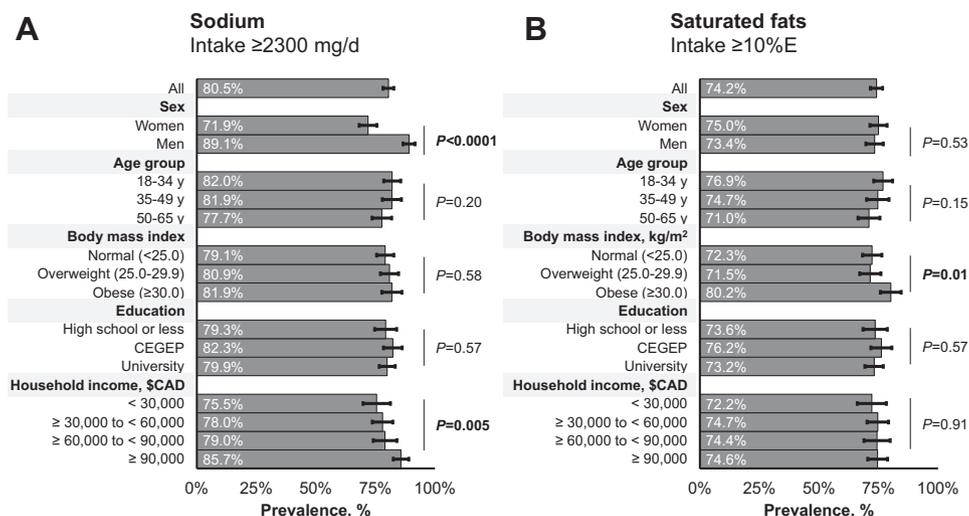
Macro- and micronutrient intake estimates are presented in **Supplemental Tables S7** and **S8**.

**Discussion**

To our knowledge, this is the first time that a Web-based 24-hour recall, the R24W,<sup>11-13</sup> was used to examine dietary



**Figure 3.** Proportion of specific foods contributing to total intake in servings per day of the Canada Food Guide milk and alternatives food group (A, mean intake = 2.1 servings per day) and meat and alternatives food group (B, mean intake = 2.4 servings per day).



**Figure 4.** Proportion (95% CI) of individuals consuming  $\geq 2300$  mg/d of sodium (A) or  $\geq 10\%$  of total energy (E) intake as saturated fats (B) in a sample of 1147 French-speaking adults from 5 administrative regions of the Province of Quebec, Canada. CEGEP, collège d'enseignement général et professionnel; CI, confidence interval.

intake of the population in Canada. Data among this age- and sex-representative sample of French-speaking adults from 5 administrative regions of the province of Quebec suggest poor adherence to current CFG recommendations, reinforcing the importance of implementing further and more effective actions to promote healthy dietary habits. The data also identified individuals at risk of having a diet of lesser quality, such as obese individuals and those with a lower socioeconomic status.

Recent meta-analyses have associated intake of V&F with reduced risk of cardiovascular diseases<sup>17,18</sup> and all-cause mortality.<sup>18,19</sup> On the basis of current dietary recommendations for adults in Canada,<sup>20</sup> close to 80% of participants in our study reported consuming insufficient amounts of V&F (including fruit juice), with an even higher prevalence among individuals with lower education level. Such trends are consistent with the CCHS 2004 data from Quebec.<sup>5</sup> Despite efforts and campaigns aimed at addressing this problem,<sup>7</sup> insufficient consumption of V&F remains a major public health concern in the province of Quebec. Higher levels of intake of whole grains have also been associated with reduced mortality risk from all causes and cardiovascular disease in recent meta-analyses<sup>18,21,22</sup> as well as with a lower risk of type 2 diabetes.<sup>23</sup> Current Canadian recommendations for intake of whole grains in adults range from 3 to 4 servings per day.<sup>20</sup> In this cohort of French-speaking adults, reported intake of whole grains were far below this recommendation, with median intake of 1.3 and 1.1 servings per day in men and women, respectively, and an estimated prevalence of insufficient consumption of 87.1%. This is consistent with previous data from Quebec, Canada, and the United States.<sup>5,16,24</sup> The low prevalence of participants who achieved age- and sex-specific recommended intake for the milk and alternative food group is also a concern, particularly among older individuals and in those with a lower level of education.

More than 80% of participants in this cohort reported consuming  $\geq 2300$  mg/d of sodium per day. Average sodium

intake among Canadians on the basis of the CCHS 2015 survey data has recently been released.<sup>25</sup> Among Canadian adults aged between 19 and 70 years, age-specific self-reported average daily intake of sodium ranged from 2820 to 3420 mg/d in men and from 2030 to 2270 mg/d in women. These values are lower than the ones reported in the present study in Quebec. Of note, data from CCHS 2004 revealed that average sodium intake in the province of Quebec was also higher than in the other Canadian provinces.<sup>26</sup> Considering that a diet high in sodium is among the 3 most important dietary risks contributing to global deaths,<sup>1</sup> concerted efforts in collaboration with the food industry are urgently required to lower sodium intake at the population level. In that regard, it will be interesting to document how the change in front-of-package labelling regulation, soon to be implemented in Canada,<sup>27</sup> influences sodium intake in the short and longer term. Finally, diet quality score assessed using the C-HEI (population mean score, 54.5) was lower than previously reported on the basis of data from the CCHS 2004, which ranged from 55.4 to 59.6 in Canadians aged 19-70 years.<sup>16</sup> Although on the basis of the same scoring scale and dietary assessment methodologies, dietary intake data from CCHS 2004 and in our study were obtained using different 24-hour recall instruments. Nevertheless, these data are concerning and suggest that overall diet quality in a French-speaking population from Quebec has not improved over the past 15 years.<sup>16</sup>

Limitations need to be addressed. Recruiting French-speaking individuals yielded a population comprising mostly Caucasian individuals, which was inevitable because the R24W was only available in French when the study was initiated. Further studies are needed to assess a more diverse population in Quebec when the English version of the R24W is validated. Our sample was also more educated than the average population in Quebec, at least in part, because participation required access to the Internet.<sup>28</sup> Diet-conscious individuals might have been more likely to participate in this study, another source of potential bias contributing to an

**Table 3. C-HEI score in a sample of 1147 French-speaking adults from 5 administrative regions of the Province of Quebec, Canada**

	n (weighted)	C-HEI score/100 (95% CI)	Percentage with score		
			< 50	≥ 50 to < 80	≥ 80
All	1147	54.5 (53.8-55.2)	36.3	61.9	1.8
Sex					
Women	576	56.4 (55.1-57.7) <sup>a</sup>	26.0	71.5	2.5
Men	571	50.1 (48.7-51.5) <sup>b</sup>	46.6	52.2	1.2
<i>P</i>		< 0.0001			
Age group, y					
18-34	408	51.7 (50.3-53.2) <sup>a</sup>	40.3	58.5	1.1
35-49	338	53.8 (52.1-55.6) <sup>a,b</sup>	34.2	63.4	2.4
50-65	400	54.1 (52.7-55.5) <sup>b</sup>	33.9	64.0	2.1
<i>P</i>		0.01			
Administrative region					
Estrie	110	53.7 (51.4-56.0)	38.5	61.5	0.0
Saguenay-Lac-Saint-Jean	107	51.9 (49.5-54.2)	39.2	59.9	1.0
Capitale-Nationale/Chaudière-Appalaches	435	53.5 (52.1-54.9)	36.1	61.0	2.9
Montreal	397	54.6 (53.2-56.0)	33.5	65.1	1.4
Mauricie	99	52.5 (49.9-55.1)	42.6	55.7	1.6
<i>P</i>		0.22			
BMI group*					
Normal (< 25.0)	453	54.4 (52.9-55.9) <sup>a</sup>	30.6	66.9	2.4
Overweight (25.0-29.9)	383	53.5 (52.0-55.0) <sup>a,b</sup>	37.7	60.5	1.8
Obese (≥ 30.0)	312	51.8 (50.2-53.4) <sup>b</sup>	42.6	56.3	1.0
<i>P</i>		0.01			
Education*					
High school or less	284	51.3 (49.6-52.9) <sup>a</sup>	48.9	48.9	2.2
CEGEP <sup>†</sup>	353	53.1 (51.6-54.6) <sup>a</sup>	37.0	61.7	1.3
University	510	55.3 (53.8-56.9) <sup>b</sup>	28.7	69.2	2.0
<i>P</i>		0.0002			
Household income, CAD\$*					
< 30,000	192	51.7 (49.6-53.7)	40.6	58.1	1.3
≥30 000 to < 60,000	328	53.1 (51.6-54.7)	37.3	60.4	2.3
≥ 60,000 to < 90,000	227	54.5 (52.7-56.2)	33.0	64.6	2.4
≥ 90,000	400	53.7 (52.3-55.1)	35.2	63.4	1.4
<i>P</i>		0.14			

The C-HEI scores are presented as mean (95% CI). The C-HEI score ranges from 0 to 100, a score of 100 reflecting perfect adherence to Canada's Food Guide (2007) recommendations. *P* values are the partial effect of the sociodemographic characteristics on intake in the linear models. All subgroup C-HEI scores are least square means adjusted for age group, sex, administrative region, BMI group, education, household income level, and weekend, when appropriate. Rounding of weighted frequencies might have caused the sample size to equal 1147 ± 1.

BMI, body mass index; CEGEP, collège d'enseignement général et professionnel; C-HEI, Canadian Healthy Eating Index; CI, confidence interval.

<sup>a,b</sup> Subgroups least square means without a common superscript letter are significantly different (*P* < 0.05, Tukey-Kramer).

\* Missing sociodemographic characteristics have been imputed. See the *Methods* section for details.

<sup>†</sup> CEGEP is a preuniversity and technical college institution specific to the Quebec educational system.

optimistic perspective of current dietary intake. One must also acknowledge that 24-hour recalls are subject to random error, which might bias estimates of food and nutrient intake.<sup>29</sup> Despite these limitations, consistent and expected associations between diet quality and sex, BMI, and socioeconomic status were observed.<sup>5,16</sup>

In conclusion, this study in adults from the province of Quebec and with access to the Internet revealed poor adherence to current dietary guidelines. Data also confirmed important inequities in healthy eating according to education and household income. These data reinforce the importance of crafting public health strategies that more efficiently affect the dietary habits of the population for optimal cardiovascular disease prevention.

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The contributions of the authors are described in the *Authors' Contributions* section of the [Supplementary Material](#).

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D.B. has received a speaking honorarium from the Dairy Farmers of Canada (DFC) in 2018. M.-C.V. is Canada Research Chair in Genomics Applied to Nutrition and Metabolic Health. B.L. is Chair of Nutrition at Laval University, which is supported by private endowments from Pfizer, La Banque Royale du Canada, and Provigo-Loblaws. He has received funding in the past 2 years from the Canadian Institutes for Health Research, Agriculture and Agri-Food Canada (Growing Forward program supported by the DFC, Canola Council of Canada, Flax Council of Canada, and Dow Agrosiences), Dairy Research Institute, Dairy Australia, and Atrium Innovations. He is an Advisory Board member of the Canadian Nutrition Society. He has received honoraria from the International Chair on Cardiometabolic risk, DFC, and the World Dairy Platform as an invited

speaker in various conferences. The remaining authors have no conflicts of interest to disclose.

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## Supplementary Material

To access the supplementary material accompanying this article, visit the online version of the *Canadian Journal of Cardiology* at [www.onlinecjc.ca](http://www.onlinecjc.ca) and at <https://doi.org/10.1016/j.cjca.2018.09.006>.