A B S T R A C T

The purpose of this study was to identify dietary patterns among adults in Québec and to determine their relationship to nutritional adequacy of the diet. We used 24-hour food recall data on 2,104 adults from the Québec nutrition survey (1990). Nutritional adequacy was assessed based on the 1990 Nutrition Recommendations for Canadians; dietary patterns were assessed via a factor analysis of the 30 food groups consumed. The three major patterns identified ('high-energy density', 'traditional' and 'health-conscious') explained 18% of the variation in food intake. Only the 'health-conscious' pattern correlated positively with the four chosen indicators of nutritional adequacy. Generally, men scored positively on the 'high-energy density' and the 'traditional' pattern whereas women scored positively on the 'health-conscious' pattern. Aside from sex, scoring was most related to age and education. The use of these patterns to define and target nutrition interventions should be tested in the aim of improving the effectiveness of health promotion.

A B R É G É

Cette étude visait à identifier les habitudes alimentaires de la population adulte du Québec et à vérifier leur relation avec la qualité nutritionnelle de l'alimentation. Nous avons utilisé les rappels alimentaires de 24 heures effectués chez 2 104 adultes lors de l'enquête provinciale sur la nutrition (1990). La qualité nutritionnelle a été déterminée en fonction des Recommandations sur la nutrition de 1990 et des habitudes alimentaires par une analyse factorielle des 30 groupes d'aliments consommés. Les principaux habitudes identifiés ('densité énergétique élevée', 'traditionnel', et 'santé') expliquaient 18 % de la variance dans l'apport alimentaire. Seul l'habitude 'santé' était corrélé positivement avec les quatre indicateurs de la qualité nutritionnelle retenus. Généralement, les hommes avaient un résultat positif pour les habitudes 'densité énergétique élevée' et 'traditionnel' et les femmes pour l'habitude 'santé'. Outre le sexe, les scores ont surtout varié en fonction de l'âge et du niveau d'éducation. L'utilisation de ces habitudes pour définir et cibler des interventions en nutrition devrait être testée en vue d'améliorer les efforts de promotion de la santé.

Dietary Patterns of Adults in Québec and their Nutritional Adequacy

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Given that many combinations of foods can lead to an adequate diet and that nutrients do not normally occur in isolation, there is increasing interest in examining patterns of food intake as opposed to intakes of individual nutrients or of groups of nutrients.¹⁻¹⁰ A better understanding of such patterns in different populations could be useful for health promotion as well as for estimating risks.

The purpose of this study was to identify major food patterns in the adult population of Quebec, and to determine their relationship with overall nutritional adequacy and with selected population characteristics.

METHODS

We used data (24-hour food recall and sociodemographic) from the Provincial Nutrition Survey carried out in 1990 among 2,118 adults (18-74 years) from different regions. Excluding pregnant women and subjects without anthropometric data left a sample of 2,104. Food consumption data were originally analyzed by Health Canada: the amount consumed for each of 32 nutrients and macro-nutrients and for 147 food groups was assessed for each subject. Sociodemographic data were originally analyzed by Santé Québec. All

data were transferred to Université Laval to be further analyzed with the Statistical Analysis System, version 6.08 (SAS Institute, Cary, NC). The 147 food groups were then combined into 30 larger food variables listed in Table I.

Dietary patterns

We used factor analysis (principal component) with varimax rotation to identify a relatively small number of components (food or dietary patterns) that summarize the information on average consumption of the 30 food groups and their relationships.¹¹ Each component identified was interpreted via its correlation (factor loadings) with the original variables (amount in grams of the 30 food groups). The first component corresponds to the combination of variables accounting for the largest amount of variation in the sample; subsequent components account for progressively smaller amounts of variation and are uncorrelated with each other. Only components with eigenvalues of 1.0 or greater were used. A score for each component (food pattern) identified was then attributed to each food recall representing the value the recall would have recorded had the components been measured directly.

Nutritional adequacy of food intake

Each food recall was assessed with each of the four indicators of nutritional adequacy we recently proposed.¹² They take into account the 1990 Nutrition Recommendations for Canadians for the 23 nutrients for which a recommendation was made, whether in absolute amounts or in % of total energy: total energy; proportion of energy from fats, saturated fats, carbohydrates and alcohol; amount of polyunsaturated fatty acids "n-6", "n-3", of

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protein, vitamins A, C, thiamin, riboflavin, niacin, B6, folate, B12, E; calcium, phosphorus, magnesium, total iron, zinc, and caffeine. We excluded iodine, sodium and vitamin D because their intake is difficult to assess. In summary, the four indicators refer to:

- global score (GS): the degree to which the 23 nutrient recommendations were met, i.e., the sum of the 23 individual scores for each nutrient (ratio between intake and recommendation or, for energy-related nutrients, ratio between recommendation and intake, for a maximum of 1), for a possible maximum of 23;
- energy score (ES): the degree to which recommendations related to energy intake were met, i.e., the sum of the 5 individual scores for each macro-nutrient (energy, total fats, saturated fats, total carbohydrates and alcohol), for a possible maximum of 5;
- number of nutrients for which intake is equal to or better than recommended levels (NN): number of recommendations for which the score reached 1, for a possible maximum of 23;
- number of nutrients for which intake is equal to or better than 66% of recommended levels (NN66): number of recommendations for which the score reached at least 0.66, for a possible maximum of 23.

Kendall's tau-b correlation coefficients were used to test for an association between the score of each food recall on each food pattern and that on each indicator of nutritional adequacy. Given the nature of these associations, the *p* value was set at 0.001.

Characteristics of the population

The association between selected population characteristics and scoring for each food pattern was estimated by an analysis of covariance with GLM procedure; total energy intake was included as a covariate to control for the amount of food consumed. LSMEANS option was used to calculate the adjusted deviations from the grand mean and to identify statistical difference ($p < 0.05$) between means.¹³ The Bonferroni correction was applied.

TABLE I
Amount Consumed (Mean, Median and Maximum) of Each of the 30 Food Groups in the 24-hour Food Recalls (N= 2,104), and Proportion of Recalls that Included Each Food Group

Food Groups	Mean $\pm$ SD (g)	Median (g)	Max. (g)	% recalls including
1. Pasta, rice, cereals and flour	115 $\pm$ 158	53	1560	80
2. White breads	43 $\pm$ 62	0	556	49
3. Whole grain breads and cereal	35 $\pm$ 63	0	643	44
4. Breads and cereals other than white and whole grain (rolls, crackers, etc.)	30 $\pm$ 46	10	397	55
5. Desserts and sweets	49 $\pm$ 58	32	677	90
6. Low-fat dairy products	175 $\pm$ 252	62	2348	72
7. Regular dairy products	93 $\pm$ 172	22	1677	67
8. High-fat dairy products	34 $\pm$ 55	10	600	58
9. Eggs	24 $\pm$ 37	7	270	64
10. Butter	6 $\pm$ 12	0	134	45
11. Margarine and oil	13 $\pm$ 16	8	135	84
12. Shortening and lard	8 $\pm$ 14	2	198	55
13. Meats, lean only	44 $\pm$ 89	0	785	35
14. Meats, lean and fat	61 $\pm$ 90	17	765	54
15. Lean poultry and fish	41 $\pm$ 81	0	674	34
16. Poultry, lean and fat	9 $\pm$ 48	0	680	6
17. Meat products (sausages, salami, etc.)	17 $\pm$ 43	0	640	29
18. Nuts, seeds, peanut butter and legumes	12 $\pm$ 35	0	506	34
19. Fresh, baked and frozen vegetables	194 $\pm$ 175	155	1490	91
20. Baked, boiled and mashed potatoes	75 $\pm$ 113	0	987	49
21. Fresh, baked and frozen fruits	133 $\pm$ 178	60	1270	64
22. Fruit juices	78 $\pm$ 161	0	1747	41
23. Salty snacks including fried and roasted potatoes	18 $\pm$ 47	0	605	23
24. Soft drinks	191 $\pm$ 335	0	3644	43
25. Alcoholic drinks	131 $\pm$ 439	0	7450	21
26. Soups	63 $\pm$ 123	0	1050	41
27. Sauces, salad dressing, etc.	20 $\pm$ 37	6	437	94
28. Tea and iced tea	115 $\pm$ 242	0	3315	31
29. Coffee	331 $\pm$ 424	237	4785	70
30. Water and mineral water	58 $\pm$ 141	0	1866	37

RESULTS

Table I shows the amount consumed of the 30 food groups, and the proportion of recalls that included them. Factor analysis revealed 14 food patterns explaining 60% of the inter-individual variation in food intake. The first three corresponded to patterns that were particularly clear and interpretable and accounted for a total of 18% of the variance. Table II reports the factor loadings or correlations of the food groups above ± 0.20 for each component or food pattern. The groups with the highest loadings (above ± 0.30) on component one were in decreasing order: salty snacks; sauces, salad dressings and the like; soft drinks; breads other than white and whole grain; high-fat dairy products; and eggs. Three groups were negatively correlated: whole grain breads and cereals; fruits; and tea. Based on its content this pattern was labelled 'high-energy density'. The groups with the highest loadings on component two were: desserts and sweets; with equal

ranking: butter *and* baked, boiled and mashed potatoes; then, margarine and oil; again with equal ranking: shortening and lard, *and* lean meats; followed by vegetables; and finally white breads. It was labelled 'traditional'. The groups with the highest loadings on component three were: fruits; low-fat dairy products; whole grain breads and cereals; vegetables; and fruit juices. However, white breads and butter also showed strong negative loadings. Regular dairy products, meat products and soft drinks showed lesser negative loadings. This pattern was labelled 'health-conscious'. For subsequent analysis we only used these three patterns. The scores for each pattern on each food recall ranged from -3.38 to 7.63 for the first pattern, from -2.21 to 6.56 for the second and from -5.34 to 3.17 for the third. In such an analysis, the mean value across the total sample for each component is zero.

Correlations between scores of each recall on each pattern and the four indicators of nutritional adequacy (Table III)

TABLE II
Factor Loadings (>0.20) of Food Groups for Each Rotated Component

Food Groups	Components (Food Patterns)		
	High-energy Density	Traditional	Health-conscious
1. Pasta, rice, cereals and flour			
2. White breads		0.34	-0.52
3. Whole grain breads and cereals	-0.29		0.39
4. Breads and cereals other than white and whole grain (rolls, crackers, etc.)	0.41		
5. Desserts and sweets		0.53	
6. Low-fat dairy products			0.44
7. Regular dairy products		0.28	-0.27
8. High-fat dairy products	0.37	0.21	
9. Eggs	0.32		
10. Butter		0.46	-0.33
11. Margarine and oil		0.41	
12. Shortening and lard		0.40	
13. Lean meats		0.40	
14. Lean and fat meats		0.27	
15. Lean poultry and fish			0.26
16. Lean and fat poultry	0.28		
17. Meat products (sausages, salami, etc.)	0.26		-0.26
18. Nuts, seeds, peanut butter and legumes			
19. Fresh, baked and frozen vegetables		0.37	0.34
20. Baked, boiled and mashed potatoes		0.46	
21. Fresh, baked and frozen fruits	-0.22		0.45
22. Fruit juices			0.30
23. Salty snacks including fried and roasted potatoes			
24. Soft drinks	0.62		-0.21
25. Alcoholic drinks	0.48		
26. Soups	0.24		
27. Sauces, salad dressing, etc.	0.22		
28. Tea and iced tea	0.60		
29. Coffee	-0.29		-0.28
30. Water and mineral water			
% variance in food intake explained	6.4%	6.2%	5.4%

Because men and women scored so differently, other characteristics were examined separately for each group. Young men scored particularly high on the 'high-energy density'; however, the older were the men, the higher they scored on the 'traditional' pattern, and to some degree, on the 'health-conscious' pattern. There were no further differences with income, education or BMI, men generally scoring higher on the 'traditional' pattern, except for those with a higher education also scoring somewhat higher on the 'health-conscious' pattern. Regarding women, the older they were, the more negatively they scored on the 'high-energy density' pattern; they also scored less negatively on the 'traditional' pattern and more positively on the 'health-conscious' pattern. Scoring on any of the patterns showed no association with income or BMI; as for men, women of higher education scored higher on the 'health-conscious' pattern. However the characteristics examined only explained 7% and 12% of the variance in scoring on this pattern for men and women, respectively, whereas they explained 23% and 25% respectively for the 'high-energy density' pattern and 52 and 54% for the 'traditional' pattern.

DISCUSSION

Fourteen food patterns were revealed explaining 60% of the total variance, with the first three accounting for 18%. Even with differences in the methods used for data collection and analysis, this is in the range of other studies.^{1,3-9} The food patterns themselves vary in each study and are generally different from those we identified. This is expected, considering the different populations, their culture and food habits. However, Nolan et al.¹⁰ recently reported an analysis among adults from the city of Montreal after using a Burke-style diet history to reflect usual dietary intakes over the previous three months. The three patterns they report are very similar to ours although they did not report the variance in consumption explained by these patterns or the total number of patterns identified.

Concerning nutritional health, Schwerin et al.^{1,2} compared the proportion in each

TABLE III
Correlation (Kendall's tau-b) Between Component Scores for Each Food Pattern and the Scores on the Four Indicators of Nutritional Adequacy for Each Food Recall

Food Patterns	Indicators of the Nutritional Adequacy of Food Recalls*			
	GS	ES	NN	NN66
1. High-energy density	0.031 (p = 0.031)	-0.11***	0.05**	0.041 (p = 0.0066)
2. Traditional	0.40***	0.041 (p = 0.0045)	0.42***	0.37***
3. Health-conscious	0.33***	0.22***	0.34***	0.30***

* GS: Global score, ES: Energy score, NN: Number of nutrients for which intake is equal to or better than recommended levels, NN66: Number of nutrients for which intake is equal to or better than 66% of recommended levels.

** p < 0.0005

***p < 0.0001

show that only the 'high-energy density' pattern correlated negatively with the ES indicator; it was also slightly correlated with the NN indicator. The 'traditional' and the 'health-conscious' pattern correlated positively with the three indicators of adequacy that included micronutrients (GS, NN, NN66), but only the latter also correlated positively with the ES. This suggests that individuals who scored higher on this pattern were also more likely to respect the limits imposed on the intake of fat by

the Nutrition recommendations and the related balance between the macronutrients. These associations between food pattern scores and those of nutritional adequacy were also observed for each sub-group whether by age, sex, education, income or BMI (results not shown).

Tables IV and V show respectively that men generally scored more positively on the 'high-energy density' and 'traditional' patterns, whereas women scored more positively on the 'health-conscious' pattern.

eating pattern group who showed no clinical or biochemical indicators of deficiency, and this in different population sub-groups; several patterns came out as best or worst, although they recommended further work on using alternative food aggregation models (they had used only 15 groups). For Randall et al.,⁷ certain eating patterns were significantly associated with better nutritional health, as measured by compliance with the National Cancer Institute (NCI) Dietary Guidelines. For both sexes, a 'fruit' pattern demonstrated greatest compliance. Among males a 'high-fat' pattern failed to comply with any of the NCI Guidelines. Randall et al.⁸ went on to examine the role of dietary patterns in the risk of colon cancer; they concluded that such multidimensional measures of diet may improve risk estimation and needed to be further studied. Nolan et al.¹⁰ report that their three patterns were associated with fat intake, their 'prudent' diet negatively and the two others ('low nutrient density' and 'traditional') positively.

In our study only the 'health-conscious' pattern was positively correlated with each of the indicators of nutritional adequacy, suggesting that such a pattern is more likely to contribute to nutritional adequacy in its different dimensions. As indicated earlier,¹² each of these indicators seems to capture a different dimension of adequacy, with the ES being concerned with the recommendations related to macro-nutrients and to the equilibrium among them, as opposed to the other three indicators which, in addition, refer to recommended levels of intake of several micro-nutrients. The 'high-energy density' pattern seems least likely to support nutritional adequacy; it correlated negatively with the ES, and correlated only slightly with the other indicators. The 'traditional' pattern, on the other hand, correlated strongly with each of the three indicators dealing with the 23 nutrients, but not with the ES. This suggests that a more 'traditional' pattern may help meet recommendations for micro-nutrients but does not do as well for macro-nutrients, a major concern for the risk of chronic diseases.

For each sex, all three patterns were associated with different sub-groups of population concerning age, and the 'health-

TABLE IV
Men: Analysis of Variance of Dietary Patterns' Scores with Selected Population Characteristics Using Energy as a Co-variate

	N	%	Dietary Pattern		
			High-energy Density	Traditional	Health-conscious
Grand mean	946*		0.26 ± 0.04†	0.37 ± 0.04	-0.06 ± 0.04
Co-variate energy			p<0.0001	p<0.0001	p<0.0017
Age (years)			p<0.0001	p<0.0001	p<0.0004
18-34	532	56	0.50 ± 0.06 ^{C‡}	0.23 ± 0.05 ^A	-0.06 ± 0.07 ^A
35-49	165	17	0.14 ± 0.09 ^B	0.45 ± 0.07 ^B	-0.21 ± 0.10 ^A
50-64	91	10	-0.07 ± 0.12 ^{AB}	0.69 ± 0.09 ^{BC}	-0.18 ± 0.13 ^A
65-74	158	17	-0.33 ± 0.10 ^A	0.75 ± 0.07 ^C	0.32 ± 0.11 ^B
Income (\$)			p<0.43	p<0.68	p<0.55
< 12 000	58	6	-0.05 ± 0.14 ^A	0.52 ± 0.11 ^A	0.06 ± 0.15 ^A
12-24 999	206	22	0.04 ± 0.08 ^A	0.58 ± 0.06 ^A	0.04 ± 0.09 ^A
25-49 999	377	40	0.08 ± 0.07 ^A	0.53 ± 0.05 ^A	-0.11 ± 0.07 ^A
≥50 000	305	32	0.17 ± 0.07 ^A	0.49 ± 0.05 ^A	-0.08 ± 0.08 ^A
Education¶			p<0.51	p<0.30	p<0.0001
Low	282	30	0.12 ± 0.07 ^A	0.61 ± 0.05 ^A	-0.36 ± 0.08 ^A
Medium	219	23	0.08 ± 0.09 ^A	0.54 ± 0.06 ^A	-0.21 ± 0.09 ^A
Collegiate	263	28	0.07 ± 0.08 ^A	0.51 ± 0.06 ^A	0.14 ± 0.09 ^B
University	182	19	-0.04 ± 0.10 ^A	0.46 ± 0.07 ^A	0.31 ± 0.10 ^B
BMI			p<0.17	p<0.05	p<0.40
< 20	67	7	0.08 ± 0.13 ^A	0.59 ± 0.10 ^A	-0.15 ± 0.14 ^A
20-25	443	47	-0.03 ± 0.06 ^A	0.49 ± 0.05 ^A	0.06 ± 0.07 ^A
> 25-27	167	17	0.04 ± 0.09 ^A	0.62 ± 0.07 ^A	0.01 ± 0.09 ^A
> 27	269	28	0.15 ± 0.07 ^A	0.42 ± 0.05 ^A	-0.05 ± 0.08 ^A
% of variance explained			23%	52%	7%

* 87 men with missing values on income or education were removed from this analysis.

† Lmean adjusted for energy intake ± sem

‡ For each population characteristic, within each column, those values having different superscripts are significantly different at p < 0.05.

¶ Education: low: 0 to a few years of high school; medium: high-school completed; college: partial or complete general or vocational college; university: partial or complete.

conscious' pattern was further associated with different sub-groups concerning education. If indeed a 'health-conscious' pattern is associated with being older and having a higher education, we may continue to witness a high incidence of chronic diseases in the coming decades. While such population characteristics explain only a small part of the variance for the 'health-conscious' pattern, they explain over 50% of the variance in the traditional pattern and nearly a quarter in the high-energy density. The association between food patterns and population characteristics could not be explored further as a 24-hour recall is a good estimate of the intake of groups, but does not necessarily reflect the habitual intake of individuals or their dominant food pattern.

The association between food patterns and nutritional adequacy is valid as they both pertain to the same food recall. In addition, the patterns we identified are

likely valid given the similar patterns identified by Nolan et al.¹⁰ from a diet history over the previous three months. However, to help target interventions favouring nutritional health and better reaching the younger adults, it may be useful in the future to examine how other population characteristics which may be more amenable to change are associated with these patterns. For example, all three patterns identified by Nolan et al. were associated with fat intake. Yet when they predicted fat intake from sociodemographic variables, there was no further effect of age, sex or educational level after they accounted for the effect of smoking, living in smaller households and being a frequent patron of fast food restaurants.

CONCLUSION

Three major dietary patterns were identified among adults in Québec. Each showed

TABLE V
Women: Analysis of Variance of Dietary Patterns' Scores with Selected Population Characteristics Using Energy as a Co-variate

	N	%	Dietary Pattern		
			High-energy Density	Traditional	Health-conscious
Grand mean	931*		-0.25 ± 0.02†	-0.34 ± 0.02	0.05 ± 0.03
Co-variate energy			p<0.0001	p<0.0001	p<0.0001
Age			p<0.0001	p<0.0002	p<0.0001
18-34	523	56	-0.09 ± 0.04 ^{C‡}	-0.38 ± 0.03 ^A	-0.12 ± 0.04 ^A
35-49	193	21	-0.33 ± 0.05 ^B	-0.30 ± 0.04 ^A	-0.10 ± 0.06 ^A
50-64	95	10	-0.59 ± 0.07 ^A	-0.29 ± 0.06 ^B	0.42 ± 0.09 ^B
65-74	120	13	-0.69 ± 0.06 ^A	-0.11 ± 0.05 ^B	0.48 ± 0.08 ^B
Income (\$)			p<0.59	p<0.73	p<0.26
< 12 000	97	10	-0.47 ± 0.07 ^A	-0.27 ± 0.05 ^A	0.05 ± 0.09 ^A
12-24 999	189	20	-0.45 ± 0.05 ^A	-0.29 ± 0.04 ^A	0.16 ± 0.07 ^A
25-49 999	402	43	-0.39 ± 0.04 ^A	-0.28 ± 0.03 ^A	0.23 ± 0.05 ^A
≥50 000	243	26	-0.39 ± 0.05 ^A	-0.24 ± 0.04 ^A	0.24 ± 0.06 ^A
Education¶			p<0.78	p<0.13	p<0.0001
Low	280	30	-0.43 ± 0.04 ^A	-0.21 ± 0.03 ^A	-0.05 ± 0.05 ^A
Medium	220	24	-0.36 ± 0.05 ^A	-0.30 ± 0.04 ^A	-0.03 ± 0.06 ^A
Collegiate	274	29	-0.39 ± 0.05 ^A	-0.31 ± 0.04 ^A	0.29 ± 0.06 ^B
University	157	17	-0.53 ± 0.06 ^A	-0.26 ± 0.05 ^A	0.41 ± 0.07 ^B
BMI			p<0.97	p<0.25	p<0.34
< 20	169	18	-0.43 ± 0.05 ^A	-0.27 ± 0.04 ^A	0.22 ± 0.07 ^A
20-25	470	50	-0.43 ± 0.04 ^A	-0.30 ± 0.03 ^A	0.23 ± 0.05 ^A
> 25-27	87	9	-0.43 ± 0.07 ^A	-0.19 ± 0.06 ^A	0.09 ± 0.09 ^A
> 27	205	22	-0.43 ± 0.05 ^A	-0.32 ± 0.04 ^A	0.14 ± 0.06 ^A
% of variance explained			25%	54%	12%

* 140 women with missing values on income or education were removed from this analysis.

† Lmean adjusted for energy intake ± sem

‡ For each population characteristic, within each column, those values having different superscripts are significantly different at p < 0.05.

¶ Education: low: 0 to a few years of high school; medium: high-school completed; college: partial or complete general or vocational college; university: partial or complete.

a different relationship to nutritional adequacy. The 'health conscious' pattern was a better predictor of adequacy than either the 'traditional' or the 'high-energy density' patterns, especially regarding the recommendations related to macro-nutrients and their equilibrium, a major consideration for the prevention of chronic diseases. Given the apparent stability of these patterns with data on the usual intake of individuals, their further study and use could help target nutrition interventions including nutri-

tion education; they could also help to better assess health risks.

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