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Dietary patterns among French-speaking men residing in Montreal, Canada

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ABSTRACT

The purpose of this study was to describe dietary patterns among 1636 French-speaking men residing in Montreal, Canada and to assess sociodemographic and lifestyle characteristics of men adhering to the dietary patterns identified. Participants were population controls from the Prostate Cancer and Environment Study, a case-control study conducted between 2006 and 2011 in Montreal. Information on diet was collected using a food frequency questionnaire, and principal component analysis, a data-driven method and *a posteriori* method, was used to identify dietary patterns. Three dietary patterns were identified; Healthy, Modified Western – Salty and Modified Western - Sweet patterns accounted for 7.0%, 5.4%, and 3.2% of the variance, respectively. The Healthy pattern was characterized by consumption of fruits, vegetables, vegetable soup, chicken, fish and seafood, cheese, rice, yogurt, and wine. The Modified Western – Salty pattern included high loadings for beef, pork, chicken, hot-dogs or sausages, cold cuts, bacon, barbecue cooking, meat slightly blackened, potatoes, pasta with tomato sauce, pizza, pastries, dark carbonated soft drinks, ice cream, and white bread. The third pattern, labelled as Modified Western - Sweet, had high loadings of cookies, muffins, cakes, pastries, pies, ice cream, fruits and vegetables. In multivariate analyses, the Healthy pattern was positively associated with higher income and education, moderate recreational physical activity and less heavy smoking, and inversely associated with French ancestry. The Modified Western – Salty pattern was positively associated with French, other European, and Latino ancestries, and with married and common-law relationships. Finally, the Modified Western – Sweet pattern was more common among men of French ancestry and users of vitamin/mineral supplements. The Healthy pattern has been frequently observed in other Western populations, but the other two are described for the first time in a study population of men.

1. Introduction

Knowledge of food consumption practices at the population level is essential for drawing comparisons across populations and for monitoring changes over time in a population. It is also necessary to enhance the understanding of the relation between dietary habits and chronic disease risk, which can inform public health recommendations. In industrialized countries, national nutritional surveys are often implemented to achieve the aforementioned population health objectives. In Canada, only two major national nutritional surveys have been conducted: the Nutrition Canada Survey in 1971–1972 (National Health and Welfare, 1977) and the Canadian Community Health Survey, Nutrition Focus in 2004 (Health Canada, 2006). In addition, a few regional provinces-wide surveys, such as the Quebec Nutrition Survey conducted in 1990, have also been carried out, dating back > 25 years (Santé Québec, 1995).

Settled by the French in the 17th century, the province of Quebec harbors a distinctive North American population. Montreal, its most populated agglomeration, is the fourth largest French-speaking city in the world after Paris, Kinshasa and Abidjan. This population shares a number of unique cultural traditions, customs, and lifestyle habits such as Quebec's traditional cuisine (Charbonneau et al., 2000). This high-energy cuisine includes considerable amounts of meat and potatoes (Benoit, 1991). Moreover, as they descend from a limited number of

Abbreviations: PCA, principal component analysis; FFQ, food frequency questionnaire; MSA, measure of sampling adequacy; BMI, body mass index

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founders, its constituents present a relatively homogeneous genetic background (Bherer et al., 2011; Roy-Gagnon et al., 2011). Because of these characteristics, French-speaking Montrealers represent an interesting population to study the role of diet in disease development. Furthermore, in the province of Quebec, men report poorer lifestyle habits than women, particularly in terms of alcohol consumption, cigarette use and diet (Tremblay, 2013), making these an important target for primary prevention.

In recent years, there has been a growing interest in the analysis of dietary patterns in relation to disease development (Hodge and Bassett, 2016). A dietary pattern is defined as a set of foods and nutrients that represents the complex nature of dietary intakes in a population of interest. Foods and nutrients are often correlated with each other and can interact in ways that make it difficult to determine their individual health effects. As a result, interest has developed in the study of dietary patterns as a means of mitigating the challenges in the study of diet and health (Jacobs Jr. et al., 2009). The overall impact of dietary patterns may also be more substantial and feasible to detect than single foods and nutrients in isolation. Importantly, dietary patterns may be more amenable to health promotion and chronic disease prevention since they are more closely aligned with overall dietary habits that may be more easily translated into public health recommendations (Hu, 2002; Newby and Tucker, 2004).

Although there are a few studies on dietary patterns in general adults in Quebec (Beaudry et al., 1998; Gougeon et al., 2015; Alles et al., 2016), none focused on men alone. Thus, we elected to use principal component analysis (PCA), an *a posteriori* or data-driven method (Gu and Scarmeas, 2011; Alles et al., 2012). A Healthy pattern emerged as the most common dietary pattern in studies published between 1981 and 2017 of Caucasian men from all over the world (Hu et al., 2000; van Dam et al., 2002; Perrin et al., 2005; Wu et al., 2006; McNaughton et al., 2007; Varraso et al., 2007; Campbell et al., 2008; Lau et al., 2008; Chan et al., 2013; Bai et al., 2015; Arabshahi et al., 2016; Ax et al., 2016). Also, distinctive dietary patterns could potentially be identified because this population's cuisine draws elements from both French and American influences. Given their common ancestry and greater homogeneity in genetic background, Canadians of French descent are of particular interest for health research (Zhou et al., 2016; Carbonneau et al., 2018; Paquette et al., 2018). Better knowledge of dietary patterns can inform future health studies in this population, as diet often needs to be considered as a main factor or as a covariate as part of analyses.

The objectives of this study were: 1) to identify dietary patterns among French-speaking adult men from Montreal, Canada and; 2) to assess the sociodemographic and lifestyle characteristics of men adhering to the dietary patterns identified.

2. Methods

2.1. Study population

This analysis is set among controls within PROtEuS (Prostate Cancer & Environment Study), a population-based case-control study which aims at identifying risk factors for prostate cancer. The design of this study, conducted in Montreal, was described previously (Blanc-Lapierre et al., 2015). Briefly, incident cases of prostate cancer were ascertained in 2005–2009 across the seven largest French-language hospitals in Montreal. Concurrently, a population control series was constituted by randomly sampling French speaking men residing in Montreal from the provincial permanent electoral list, and frequency-matching them to prostate cancer cases by age (± 5 years). Eligible controls had no history of prostate cancer. In all, 1919 cases and 1991 controls aged 39–75 years were recruited; participation rates were 79% for cases and 56% for controls. Reasons for non-participation were refusal (86%), unable to trace (11%), death with no proxy respondent available (1%), language barrier (1%) and too sick to participate (1%) among controls.

The present analysis was restricted to the 1636 controls (82% of participating controls) that chose to have their interviews conducted in French.

2.2. Data collection

Between 2006 and 2011, face-to-face interviews were conducted to collect information on sociodemographic, lifestyle and environmental factors. Dietary information was obtained by means of a 63-item food frequency questionnaire (FFQ). The FFQ was based on a validated instrument developed by the Canadian Cancer Registries Epidemiology Research Group, with minor modifications to reflect the specificity of the study population (Pan et al., 2004). Subjects were asked about their consumption of food at home, at work and restaurants, two years prior to the interview. Food intake was recorded in terms of the frequency of use per day, week or month of commonly used portions. Given seasonal variations in consumption, participants were asked how many months per year they ate various fruits. Complementary questions on the consumption of fat from meat, skin of poultry and cooking methods were also included. Data on lifelong use of coffee, black tea, green tea, beer, wine and spirits were collected and the consumption level two years before the interview was used for analysis. The study was approved by the ethics boards of all participating institutions (Supplementary material Table 1) and subjects provided written informed consent.

2.3. Statistical analysis

Our main analysis was conducted on the entire sample of French-speaking controls. In order to identify dietary patterns, PCA was performed on the correlation matrix of the weekly intake of the 72 following variables: the 63 items from the FFQ, coffee, black tea, green tea, beer, wine and spirits consumption, and the three complementary questions. Dietary variables were log transformed because of skewed distributions. Bartlett's test of sphericity and the Kaiser-Meyer-Olkin measure of sampling adequacy (MSA) were used to verify the appropriateness of the PCA. The correlation matrix determinant was used to confirm the absence of an identity or singular matrix (Norman and Streiner, 2008). The principal axis method was used to extract the components, followed by a varimax (orthogonal) rotation. To ensure that the components were independent, an oblique rotation was performed. A component was retained when it met the following criteria: eigenvalue > 2.0, identification of a breaking point in the scree plot and factor interpretability (Norman and Streiner, 2008).

Variables were considered to load on a component if they had an absolute factor loading ≥ 0.2 (Norman and Streiner, 2008). Dietary patterns were labelled according to the variables loaded on a retained component. As an additional assessment of the robustness of the dietary patterns identified, we re-ran the analysis by randomly placing subjects into one of two equal sized groups, or split-samples, and a sensitivity analysis was performed on French-speaking men who were explicitly of French descent. The factor score for each dietary pattern was computed by determining the optimal regression weights, multiplying subjects' answers to the questionnaire items by these weights and summing the products. Then, each dietary pattern was categorized into quartiles based on the distribution of factor scores. Differences in sociodemographic and lifestyle characteristics between subjects adhering to the different quartiles of each dietary pattern were detected by ANOVA and the chi-square test. Associations between sociodemographic and lifestyle characteristics and dietary patterns were also examined with multivariate linear regression models. All analyses were performed using SAS (version 9.4; SAS Institute, Cary, NC.).

Table 1
Selected sociodemographic and lifestyle characteristics of French-speaking male subjects, Montreal, Canada, 2006–2011.

Characteristics	Subjects	
	(n = 1636)	
Age in years, mean (SD)	64.8	(6.9)
Ancestry, n (%)		
Sub-Saharan	68	(4.2)
Asian	21	(1.3)
French	1147	(70.1)
Other European	285	(17.4)
Greater Middle East	70	(4.3)
Latino	30	(1.8)
Other	15	(0.8)
Household income in $ CAD, n (%)		
< 20,000	196	(12.0)
20,000–29,999	208	(12.7)
30,000–49,999	389	(23.8)
50,000–79,999	351	(21.5)
> 80,000	344	(21.0)
Unknown	148	(9.1)
Education, n (%)		
Primary school of less	377	(23.0)
High school	491	(30.0)
College	302	(18.5)
University	465	(28.4)
BMI in kg/m^2, mean (SD)	27.2	(4.4)
Ever smoked, n (%)		
No	397	(24.3)
Yes	1239	(75.7)
Physical activity, recreational, n (%)		
Not very active	537	(32.8)
Moderately active	767	(46.9)
Very active	331	(20.2)
Physical activity, occupational, n (%)		
Not very active	331	(20.2)
Moderately active	530	(32.4)
Very active	775	(47.4)
Physical activity, residential, n (%)		
Not very active	457	(27.9)
Moderately active	839	(51.3)
Very active	340	(20.8)
Last prostate screening test[a], n (%)		
≤2 years before the interview	1242	(75.9)
2–5 years ago	125	(7.6)
≥5 years ago	63	(3.9)
Had screening but do not know when	25	(1.5)
Do not know if ever screened	26	(1.6)
Never screened	155	(9.5)
Ever use of vitamins or mineral supplements, n (%)		
No	1028	(62.8)
Yes	607	(37.1)

[a] Prostate specific antigen and/or digital rectal examination.

3. Results

3.1. Study population

Table 1 presents selected sociodemographic and lifestyle characteristics of the 1636 French-speaking male participants. Their mean age was 65 years, and most were Canadians of French descent (70%), of other European ancestry (17%) or of African descent (4%). For 23% of subjects, the educational level attained was primary school or less. About 25% of men had a yearly family income below $CAD30,000. On average, men were overweight at the time of dietary assessment with a mean body mass index (BMI) of 27.2 kg/m^2 (World Health Organization, 2000), 76% had ever smoked, 47% reported their occupational physical activity level as very active, and 37% of men had used vitamin or mineral supplements. We compared study participants and non-participants using four ecological variables derived from census tract data for 2006. The percentages of subjects living in areas with a greater proportion of recent immigrants were 5% and 6%, for participants and non-participants, respectively. Corresponding values were 7% and 7% for higher unemployment rate, 19% and 20% of adults without a high school diploma, and 22% and 25% in the lowest quintile of household income, suggesting a slight trend towards higher socio-economic status among participants, a feature commonly encountered.

3.2. Dietary patterns

The correlation matrix was neither a singular nor an identity matrix, according to its determinant and to Bartlett's test of sphericity (Norman and Streiner, 2008). The global MSA was 0.83 which is meritorious according to Kaiser and Rice (Kaiser and Rice, 1974). Four variables (margarine on potatoes, vegetables or bread; butter on potatoes, vegetables or bread; skin on poultry; and spirits) had a MSA < 0.5 and were not retained for subsequent analysis. After an orthogonal rotation, a three components solution emerged; results are shown in Table 2. The eigenvalues were 5.94, 4.70 and 2.55 and the variance explained by these three components was 15.6%. The three retained components were identified as distinct dietary patterns, labelled respectively as Healthy, Modified Western – Salty, and Modified Western – Sweet. The Healthy pattern was characterized by high consumption of fruits, vegetables, chicken, turkey or other poultry, veal, lamb, fish and seafood, cheese, yogurt or wine, and no consumption of white bread, donuts, cakes, pastries or pies. The Modified Western – Salty pattern included high loadings for beef, pork, chicken, hot-dogs or sausages, cold cuts, bacon, breakfast sausages, barbecue cooking, meat slightly blackened, fried or pan fried potato, not-fried potato, pasta with tomato sauce, pizza, donuts, cakes, pastries, pies, dark carbonated soft drinks, ice cream, white bread, and no consumption of brown bread. The final pattern was labelled Modified Western – Sweet, based on its high loadings of cookies, muffins, donuts, cakes, pastries, pies, oatmeal or cream of wheat, breakfast cereals, ice cream, fruits and vegetables.

Sociodemographic and lifestyle characteristics of study subjects differed according to the degree to which they aligned with the three dietary patterns identified, as shown in Table 3. When compared to men whose factor scores placed them in the lowest quartile, those in the highest quartile of the Healthy pattern were more likely to have completed college or university, to have a family income higher than $CAD50,000, to ever have had a prostate cancer screening test, to be of African or European (other than French) ancestry, and from the Greater Middle East. Men in the highest quartile of the Modified Western – Salty pattern were more likely to be younger, to be of French descent, to have a family income higher than $CAD50,000, to have a higher BMI and to have ever smoked, compared to men in the lowest quartile. Finally, men in the highest quartile of the Modified Western – Sweet pattern were more likely to be of French descent and to have completed high school, as compared to men in the lowest quartile.

Associations between sociodemographic, lifestyle characteristics and dietary patterns were also examined with multivariate linear regression models, as shown in Table 4. Among all factors considered, only a few were associated with the dietary pattern scores, upon mutual adjustments. French ancestry and heavy cigarette smoking showed an inverse association with the Healthy pattern, whereas higher family income and education level, as well as being moderately active recreationally were positively associated with this pattern. Age was inversely associated with the Modified Western – Salty pattern score, whereas French, other European and Latino ancestries, heavy cigarette smoking, married and common law relationships were positively associated. Finally, French ancestry and ever use of vitamin or supplements were positively associated with the Modified Western – Sweet pattern score, whereas heavy cigarette smoking was negatively associated with it. No association was found with any of the patterns for BMI, and health-related behaviors such as occupational and residential physical activity, or prostate cancer screening.

In analyses of French-speaking men who were explicitly of French descent, results were consistent with those from the main analyses (data

Table 2
Weekly intake of 68 food and beverage items and rotated factor loadings for items[a].

Food and beverage items	Servings per week	(SD)	Rotated factor loadings		
			Pattern 1 Healthy	Pattern 2 Modified Western – Salty	Pattern 3 Modified Western – Sweet
Banana	2.7	(2.73)	0.16	−0.19	**0.32**[b]
Apple, pear	2.8	(3.40)	**0.32**	−0.14	0.14
Orange, grapefruit, tangerine, clementine	2.3	(2.94)	**0.35**	−0.12	0.08
Peach, nectarine	0.6	(1.34)	**0.33**	−0.08	−0.06
Canned fruit, fruit sauce, fruit salad	0.7	(1.60)	−0.02	0.06	**0.30**
Apricot	0.2	(0.88)	**0.34**	−0.07	−0.07
Cantaloupe	0.5	(0.90)	**0.45**	−0.03	0.02
Watermelon, honeydew melon	0.4	(0.66)	**0.41**	−0.03	−0.03
Strawberry, raspberry, blueberry	1.1	(1.50)	**0.32**	−0.05	**0.23**
Other fresh fruit	1.6	(1.89)	**0.47**	−0.05	**0.22**
Potato, fried or pan fried	0.8	(1.00)	−0.08	**0.52**	−0.04
Potato, not fried	2.6	(2.30)	−0.12	**0.30**	**0.42**
Sweet potato	0.2	(0.61)	0.07	−0.02	0.16
Baked bean, other legume or lentil	0.9	(1.16)	**0.33**	−0.06	0.09
Broccoli	1.3	(1.36)	**0.44**	−0.07	**0.31**
Carrot	2.1	(1.89)	**0.29**	0.03	**0.49**
Spinach	0.5	(0.76)	**0.46**	−0.09	0.04
Coleslaw, cabbage, cauliflower, Brussel sprout	0.9	(1.10)	**0.35**	0.05	0.18
Dark lettuce	2.4	(2.26)	**0.62**	0.08	0.05
Tomato	3.0	(2.36)	**0.52**	0.18	0.05
Sweet red pepper	0.9	(1.35)	**0.47**	0.06	0.04
Other vegetable	2.8	(2.16)	**0.39**	0.11	0.13
Tomato soup or cream of tomato	0.4	(0.70)	0.04	**0.23**	**0.28**
Vegetable soup	1.3	(1.51)	**0.22**	0.10	**0.40**
Tofu, soybean	0.2	(0.62)	0.16	−0.17	0.17
Ketchup, salsa	0.8	(1.32)	−0.08	**0.36**	**0.24**
Salad dressing, mayonnaise (excl. low fat)	2.3	(2.31)	**0.45**	**0.26**	0.09
Beef	1.9	(1.42)	−0.09	**0.50**	0.13
Pork	1.1	(0.90)	0.03	**0.32**	0.13
Chicken, turkey or other poultry	1.9	(1.07)	**0.21**	0.15	0.13
Veal, lamb	0.4	(0.60)	**0.38**	0.04	−0.16
Liver	0.2	(0.30)	0.14	0.12	0.07
Hot-dog or sausage	0.4	(0.60)	−0.05	**0.44**	−0.03
BBQ	1.1	(1.41)	**0.21**	**0.35**	−0.12
Cold cuts	1.3	(1.66)	−0.01	**0.40**	0.04
Bacon, breakfast sausage	0.5	(0.94)	−0.10	**0.51**	0.05
Fish, seafood	1.3	(1.00)	**0.41**	−0.13	0.08
Egg, omelet or quiche	1.8	(1.74)	0	**0.30**	0.14
Cheese	3.9	(2.79)	**0.26**	**0.26**	0.11
Pasta with tomato sauce	1.1	(0.93)	0.13	**0.30**	−0.07
Pasta with cheese without tomato sauce	0.2	(0.43)	−0.03	0.14	−0.01
Pizza	0.4	(0.57)	0.03	**0.25**	−0.07
Cookie, muffin	2.5	(3.40)	−0.15	0.11	**0.34**
White bread	6.0	(8.55)	**−0.25**	**0.30**	−0.15
Brown bread	5.7	(7.09)	0.11	**−0.27**	**0.28**
Rice	1.6	(1.74)	**0.20**	−0.13	0.04
Donut, cake, pastry and pie	1.5	(2.37)	**−0.21**	**0.26**	**0.33**
Oatmeal or cream of wheat	0.5	(1.30)	0.06	−0.14	**0.30**
Breakfast cereal	2.0	(2.52)	0.09	−0.19	**0.40**
Real fruit juice	3.8	(4.23)	0.03	0.02	0.19
Tomato or vegetable juice	1.2	(1.90)	0.03	**0.22**	**0.25**
Glass of milk or milk in cereal	4.7	(5.95)	0.03	−0.10	**0.42**
Cream or milk in coffee or tea	12.0	(14.14)	−0.11	**0.31**	0
Dark carbonated soft drink	2.6	(6.93)	−0.17	**0.37**	0.06
Other carbonated soft drink	0.9	(2.65)	−0.07	0.09	0.01
Fried food	0.3	(0.57)	0.04	**0.20**	0
Nut or peanut butter	2.8	(2.87)	0.15	−0.04	**0.33**
Chips, corn chips, popcorn, tortilla	0.9	(1.61)	−0.02	**0.38**	0.08
Chocolate	0.8	(1.75)	0.04	0.18	0.17
Yogurt	2.4	(3.00)	**0.20**	−0.17	**0.31**
Ice cream	0.8	(1.42)	−0.01	**0.23**	**0.27**
Fat of beef or pork	1.6	(34.92)	−0.04	−0.08	0
Meat slightly blackened	1.0	(1.82)	0.12	**0.47**	−0.05
Coffee	15.3	(14.91)	−0.05	**0.28**	−0.05
Black tea	2.6	(7.01)	0	0.05	0.12
Green tea	1.3	(4.16)	0.15	−0.09	0.14
Beer	3.8	(9.82)	−0.08	0.18	−0.09
Wine	4.3	(7.02)	**0.32**	0.02	**−0.29**
Proportion of variance explained (%)			7.0	5.4	3.2
Cumulative variance explained (%)			7.0	12.4	15.6

[a] Variables were considered to load on a component if they had an absolute factor loading ≥0.2 and are presented in bold.

[b] Variables were considered to load on a component if they had an absolute factor loading ≥0.2.

Table 3
Selected sociodemographic and lifestyle characteristics of 1636 French-speaking male subjects by quartile of dietary pattern scores, Montreal, Canada 2006–2011[a].

Characteristics	Pattern 1 Healthy				Pattern 2 Modified Western - Salty				Pattern 3 Modified Western - Sweet			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Age in years, mean (SD)	$p = 0.10$[b]				$p < 0.001$[b]				$p < 0.007$[b]			
	65 (7)	65 (7)	64 (7)	65 (7)	66 (7)	65 (7)	65 (7)	63 (7)	64 (7)	65 (7)	64 (7)	66 (7)
Ancestry, %	$p < 0.001$[c]				$p < 0.001$[c]				$p < 0.001$[c]			
Sub-Saharan	3	4	4	6	12	3	2	0	7	5	3	2
Asian	1	1	2	1	4	1	1	0	2	2	1	0
French	80	75	68	58	54	70	75	82	47	70	80	84
Other European	13	13	18	25	17	18	19	16	32	15	13	10
Greater Middle East	2	4	4	7	9	6	2	1	9	5	2	2
Latino	1	2	3	2	3	2	2	1	2	2	2	1
Other	1	1	1	1	1	1	1	1	2	1	1	1
Annual household income in $ CAD, %	$p < 0.001$[c]				$p < 0.001$[c]				$p = 0.16$[c]			
< 20,000	22	12	9	5	20	13	9	5	13	12	9	14
20,000–29,999	15	15	10	11	15	15	11	10	14	13	12	13
30,000–49,999	27	27	24	18	25	24	25	21	21	25	25	25
50,000–79,999	16	22	23	25	17	19	24	25	19	21	23	23
> 80,000	11	15	25	33	12	18	23	32	22	23	23	16
Other	8	11	9	8	11	11	8	7	11	7	8	10
Education, %	$p < 0.001$[c]				$p = 0.28$[c]				$p = 0.09$[c]			
Primary school or less	35	27	18	13	23	25	25	20	24	20	24	25
High school	38	32	31	20	27	28	31	34	27	29	29	35
College	14	18	19	24	20	18	16	21	16	22	18	18
University	13	24	33	44	30	30	28	26	32	30	29	23
BMI in kg/m^2, mean (SD)	$p = 0.05$[c]				$p < 0.001$[c]				$p = 0.34$[c]			
Underweight < 18.5	3	1	2	1	4	1	1	1	2	2	1	2
Normal weight [18.5–24.9]	32	26	29	31	37	29	26	25	30	31	26	30
Pre-obesity [25.0–29.9]	41	50	49	47	43	50	50	45	45	44	54	45
Obesity class 1 [30.0–34.9]	18	18	14	18	12	14	19	23	19	19	14	16
Obesity class 2 [35.0–39.9]	5	5	5	2	3	4	4	5	3	4	4	5
Obesity class 3 > 40	2	1	1	2	1	2	1	2	1	1	1	2
Number of cigarettes in pack-years	$p < 0.001$[c]				$p < 0.001$[c]				$p = 0.11$[c]			
Tertile 1 [1–3.9]	23	33	33	43	44	34	26	28	30	30	34	38
Tertile 2 [3.9–31.5]	25	29	41	36	31	33	37	30	33	33	35	30
Tertile 3 > 31.5	51	38	26	21	24	34	36	42	37	36	31	32
Physical activity, recreational, %	$p < 0.001$[c]				$p = 0.03$[c]				$p = 0.28$[c]			
Not very active	50	37	25	19	38	36	28	29	36	33	29	33
Moderately active	35	44	53	56	45	44	50	49	46	48	49	44
Very active	15	20	22	25	17	20	23	23	18	18	22	23
Physical activity, occupational, %	$p = 0.05$[c]				$p = 0.75$[c]				$p = 0.31$[c]			
Not very active	15	19	22	24	18	22	19	22	17	22	22	21
Moderately active	33	32	32	33	34	32	32	32	30	32	34	33
Very active	51	50	46	43	48	46	49	46	52	46	44	47
Physical activity, residential, %	$p < 0.001$[c]				$p < 0.006$[c]				$p = 0.24$[c]			
Not very active	42	29	22	19	33	33	24	23	30	30	28	24
Moderately active	42	52	56	56	46	46	57	57	51	52	50	52
Very active	16	19	23	25	21	22	20	21	19	18	23	24
Timing of last prostate screening test[d], %	$p < 0.0003$[c]				$p = 0.19$[c]				$p = 0.57$[c]			
< 2 years ago	69	75	79	82	76	79	74	75	72	78	75	78
2–5 years ago	8	9	8	6	6	9	8	7	9	5	8	9
≥5 years ago	4	4	3	5	4	4	4	4	5	4	4	3
Had screening but do not know when	3	2	1	1	1	2	2	2	2	2	2	1
Do not know if ever screened	2	2	2	1	3	1	1	2	2	1	2	2
Never screened	14	10	8	6	11	6	11	11	12	10	10	7
Number of screening tests in previous 5 years[e], %	$p < 0.001$[c]				$p = 0.32$[c]				$p = 0.49$[c]			
0	20	15	13	12	16	11	15	17	17	15	16	12
1–4	29	32	32	29	29	30	30	33	30	30	30	33
≥5	37	42	48	52	45	49	49	41	42	46	46	45
Unknown	15	11	8	7	10	10	10	10	11	9	9	11
Ever use of vitamins or mineral supplements, %	$p = 0.07$[c]				$p = 0.47$[c]				$p < 0.001$[c]			
No	67	66	60	58	61	61	63	66	73	64	58	57
Yes	33	34	40	42	39	39	37	34	27	36	42	44

[a] Numbers within table may not sum to 100% due to missing data and participants who did not know.
[b] p-Value resulting from ANOVA comparing means across the four quartiles.
[c] p-Value resulting from chi-square test comparing proportions across the four quartiles.
[d] Screening test by prostate-specific antigen (PSA) and/or digital rectal exam (DRE).
[e] Screening test by PSA.

Table 4
Associations[a] between sociodemographic and lifestyle characteristics and dietary pattern scores (n = 1636).

	Pattern 1 Healthy		Pattern 2 Modified Western - Salty		Pattern 3 Modified Western - Sweet	
	β	95% CI	β	95% CI	β	95% CI
Age	0.005	[−0.01; 0.02]	**−0.02**	[**−0.04**; **−0.01**][b]	0.003	[−0.01; 0.02]
Ancestry						
Sub-Saharan	Reference		Reference		Reference	
Asian	−0.25	[−1.11; 0.60]	0.20	[−0.67; 1.08]	−0.55	[−1.48; 0.38]
French	**−0.50**	[**−0.95**; **−0.06**]	**1.31**	[**0.85**; **1.76**]	**0.66**	[**0.17**; **1.14**]
Other European	−0.07	[−0.55; 0.41]	**1.17**	[**0.68**; **1.66**]	−0.02	[−0.54; 0.50]
Greater Middle East	0.09	[−0.50; 0.67]	0.59	[−0.01; 1.19]	−0.20	[−0.84; 0.44]
Latino	0.06	[−0.68; 0.80]	**0.90**	[**0.14**; **1.66**]	0.03	[−0.78; 0.83]
Other	−0.44	[−1.42; 0.54]	0.98	[−0.02; 1.98]	−0.12	[−1.19; 0.94]
Annual household income in $ CAD						
< 20,000	Reference		Reference		Reference	
20,000–29,999	0.29	[−0.06; 0.64]	0.007	[−0.35; 0.36]	−0.007	[−0.39; 0.37]
30,000–49,999	0.24	[−0.08; 0.56]	0.02	[−0.30; 0.35]	−0.02	[−0.37; 0.33]
50,000–79,999	**0.47**	[**0.13**; **0.81**]	0.20	[−0.15; 0.54]	−0.08	[−0.45; 0.29]
> 80,000	**0.54**	[**0.16**; **0.91**]	0.31	[−0.07; 0.69]	−0.24	[−0.65; 0.17]
Other	0.30	[−0.09; 0.69]	−0.11	[−0.51; 0.29]	−0.09	[−0.52; 0.34]
Education						
Primary school or less	Reference		Reference		Reference	
High school	0.07	[−0.17; 0.31]	−0.11	[−0.23; 0.26]	0.02	[−0.25; 0.28]
College	**0.36**	[**0.08**; **0.65**]	−0.19	[−0.48; 0.11]	−0.14	[−0.45; 0.17]
University	**0.46**	[**0.17**; **0.74**]	−0.17	[−0.46; 0.12]	−0.21	[−0.52; 0.10]
Marital status						
Single	Reference		Reference		Reference	
Married	0.27	[−0.07; 0.61]	**0.57**	[**0.22**; **0.92**]	0.08	[−0.29; 0.45]
Common law	0.15	[−0.25; 0.55]	**0.45**	[**0.04**; **0.85**]	−0.04	[−0.48; 0.39]
Separated	0.07	[−0.54; 0.67]	0.22	[−0.39; 0.84]	−0.03	[−0.69; 0.62]
Divorced	−0.09	[−0.50; 0.32]	0.27	[−0.15; 0.68]	−0.05	[−0.49; 0.40]
Widower	0.002	[−0.51; 0.52]	0.12	[−0.41; 0.65]	0.14	[−0.43; 0.70]
Member of religious order	0.62	[−0.70; 1.94]	0.27	[−1.08; 1.62]	0.20	[−1.24; 1.63]
BMI in kg/m^2						
Underweight < 18.5	Reference		Reference		Reference	
Normal weight [18.5–24.9]	0.22	[−0.54; 0.97]	0.03	[−0.74; 0.81]	−0.06	[−0.89; 0.76]
Pre-obesity [25.0–29.9]	0.20	[−0.56; 0.96]	0.12	[−0.65; 0.89]	−0.07	[−0.89; 0.75]
Obesity class 1 [30.0–34.9]	0.23	[−0.54; 1.01]	0.35	[−0.44; 1.14]	−0.09	[−0.93; 0.75]
Obesity class 2 [35.0–39.9]	0.18	[−0.67; 1.04]	0.31	[−0.56; 1.18]	0.09	[−0.84; 1.02]
Obesity class 3 > 40	0.22	[−0.88; 1.31]	0.22	[−0.90; 1.34]	0.30	[−0.90; 1.49]
Number of cigarettes in pack-years						
Tertile 1 [1–3.9]	Reference		Reference		Reference	
Tertile 2 [3.9–31.5]	0.007	[−0.20; 0.22]	0.14	[−0.07; 0.36]	−0.12	[−0.35; 0.11]
Tertile 3 > 31.5	**−0.26**	[**−0.48**; **−0.04**]	**0.28**	[**0.06**; **0.50**]	**−0.25**	[**−0.49**; **−0.02**]
Physical activity						
Recreational						
Not very active	Reference		Reference		Reference	
Moderately active	**0.27**	[**0.06**; **0.49**]	0.06	[−0.15; 0.28]	0.02	[−0.21; 0.25]
Very active	0.22	[−0.05; 0.49]	0.02	[−0.25; 0.30]	0.08	[−0.22; 0.37]
Occupational						
Not very active	Reference		Reference		Reference	
Moderately active	−0.06	[−0.31; 0.19]	−0.04	[−0.30; 0.21]	−0.07	[−0.34; 0.20]
Very active	0.001	[−0.25; 0.25]	−0.02	[−0.28; 0.23]	−0.26	[−0.53; 0.02]
Residential						
Not very active	Reference		Reference		Reference	
Moderately active	0.19	[−0.03; 0.40]	0.16	[−0.06; 0.39]	0.05	[−0.18; 0.29]
Very active	0.19	[−0.09; 0.47]	0.05	[−0.24; 0.33]	0.16	[−0.14; 0.46]
Timing of last prostate cancer screening tests[c]						
< 2 years ago	Reference		Reference		Reference	
2–5 years ago	−0.10	[−0.43; 0.24]	0.08	[−0.26; 0.42]	−0.006	[−0.37; 0.36]
≥5 years ago	0.14	[−0.38; 0.65]	−0.22	[−0.74; 0.30]	−0.09	[−0.65; 0.47]
Had screening but do not know when	−0.09	[−0.83; 0.64]	0.14	[−0.61; 0.90]	−0.09	[−0.89; 0.72]
Do not know if ever screened	0.31	[−0.44; 1.06]	−0.18	[−0.95; 0.58]	0.01	[−0.80; 0.83]
Never screened	−0.26	[−0.78; 0.25]	−0.05	[−0.58; 0.47]	−0.08	[−0.64; 0.48]
Number of screening tests in previous 5 years[d]						
0	Reference		Reference		Reference	
1–4	0.01	[−0.44; 0.46]	−0.10	[−0.56; 0.36]	0.10	[−0.39; 0.59]
≥5	0.05	[−0.41; 0.50]	−0.12	[−0.58; 0.35]	−0.04	[−0.54; 0.45]
Unknown	−0.29	[−0.78; 0.20]	0.003	[−0.50; 0.51]	0.009	[−0.53; 0.54]
Ever use of vitamins or mineral supplements						
No	Reference		Reference		Reference	
Yes	0.08	[−0.10; 0.26]	−0.08	[−0.27; 0.09]	**0.23**	[**0.04**; **0.42**]
Unknown	−1.56	[−5.02; 1.90]	0.18	[−3.34; 3.71]	0.06	[−3.70; 3.81]

[a] Associations were estimated with multivariate linear models adjusted for all sociodemographic and lifestyle characteristics variables altogether in a same model. Significant associations are presented in bold.

[b] Value in bold are statistically significant.
[c] Screening test by prostate-specific antigen (PSA) and/or digital rectal exam (DRE).
[d] Screening test by PSA only.

not shown).

4. Discussion

We aimed to identify dietary patterns in a distinctive North American population strongly influenced by a French heritage. To our knowledge, this is the first report of dietary patterns restricted to men only in Montreal, QC. Three dietary patterns were identified using PCA. The highest percentage of variance was explained by the Healthy pattern (7.0%), followed by the Modified Western – Salty pattern (5.4%) and the Modified Western – Sweet food pattern (3.2%).

In univariate analyses based on scores' quartiles, several associations emerged between sociodemographic and lifestyle characteristics, and the three dietary patterns. However, many of these disappeared in multivariate linear models. The Healthy pattern was associated with higher income and education, moderate recreational physical activity and less heavy smoking, reflecting that a higher socioeconomic status results in healthier dietary and lifestyle choices. The Modified Western – Salty pattern was associated with French, other European, and Latino ancestry, and with married and common-law relationships, who apparently resorted more often to eating highly processed foods and rapidly-prepared meals. Also, age was inversely associated with this food pattern, in accordance with previous observations that younger men in Quebec report a lower food quality (Tremblay, 2013). Finally, the Modified Western – Sweet pattern was more common among men of French ancestry and users of vitamin/mineral supplements. Men eating this unique dietary pattern had a preference for both nutritious (fruits and vegetables) and less nutritious (cookies, muffins, donuts, cakes, pastries, pies, and ice cream) sweet foods. After multivariate adjustments, no association was observed between BMI, timing and frequency of prostate cancer screening, and any of the dietary patterns. Men adhering to a healthier dietary pattern could have been expected to have been screened more frequently and recently. Our findings probably reflect the fact that there is universal access to healthcare in Quebec, and screening was often part of yearly exams at the time of study, irrespective of subjects' characteristics.

4.1. Previous studies

Even though several studies on dietary patterns have been published since the first report by Schwerin et al. (1981) none of them addressed data-driven dietary patterns of men only in the province of Quebec. Supplementary material Table 2 presents the 22 studies on dietary patterns of Caucasian men published since 1981. It shows that two dietary patterns were identified in 9 of the 22 studies, with the two most often identified patterns being the Healthy and the Western patterns (Hu et al., 2000; van Dam et al., 2002; Perrin et al., 2005; Wu et al., 2006; McNaughton et al., 2007; Varraso et al., 2007; Campbell et al., 2008; Lau et al., 2008; Chan et al., 2013; Bai et al., 2015; Arabshahi et al., 2016; Ax et al., 2016). Five of 22 studies identified three dietary patterns (Tseng et al., 2004; Ambrosini et al., 2008; Charreire et al., 2011; Ruusunen et al., 2014; Shin et al., 2015). In all 22 studies, a Healthy pattern or a Prudent pattern or a dietary pattern rich in fruit and vegetables was identified, a pattern rich in meat was identified six times, and the Modified Western – Sweet pattern was never reported. Most Healthy or Prudent patterns included the following foods: fruits, vegetables, and fish. As it is the first time that a Healthy, Modified Western – Salty and Modified Western – Sweet patterns are identified together among Caucasian men, these findings are novel. The proportion of variance explained in our study (15.6%) is comparable to that observed in the aforementioned studies, which ranged from 10.80 to 32.84%. It is noteworthy than even in studies of French or Canadians, the number and name of dietary patterns were different. Indeed, in studies from France, Perrin et al. (2005) identified 2 dietary patterns: Western and Prudent (total variance explained: 26.7%) and Charreire et al. (2011) identified the patterns Alcohol & meat, Healthy food and Convenience food (total variance explained: 17.6%). Among studies of Canadians, one (Walker et al., 2005) found 4 dietary patterns: Healthy living, Traditional Western, Processed, Beverages (total variance explained: 10.5%), while Campbell et al. (2008) found 2 dietary patterns: Prudent and Western (total variance explained: 8.0%). Prudent and Western dietary patterns were the most common regardless of the country (Hu et al., 2000; van Dam et al., 2002; Perrin et al., 2005; Wu et al., 2006; Varraso et al., 2007; Campbell et al., 2008; Chan et al., 2013; Bai et al., 2015). In summary, the results obtained in our study are unique, with Healthy, Modified Western – Salty and Modified Western - Sweet patterns identified, possibly resulting from the mixture between French cuisine and Western influences.

A study published by Alles et al. (2016) looked at the dietary patterns of men and women in France and in Quebec. The dietary patterns of Quebecers were derived from the Quebec Longitudinal Study on Nutrition and Successful Aging (NuAge), including 763 men and 833 women aged 67–84 years at baseline in 2003–2005. Participants were selected from a random sample of the Quebec Medicare database using stratified sampling by age and sex. Three dietary patterns were obtained by factor analysis (men and women combined): Healthy, Western and Traditional patterns. These three patterns explained 53.5% of the total variance, which is much higher than in our study. Similarly to us, they identified three dietary patterns and both studies observed a healthy pattern. The NuAge study focused on older men and women (mean age = 74 years), whereas ours focused on men only (mean age = 65 years). The presence of a Western pattern and of a Traditional pattern in NuAge could be explained by the older age of participants, who could have been adhering more closely to older customs. It is interesting to note that in both the NuAge study and ours, a higher educational level was associated with the Healthy pattern, reflecting higher intakes of fruits and vegetables, white meat and fish. Moreover, smoking was associated with the Western pattern in NuAge and with the Modified Western – Salty pattern in our study, highlighting the link between less healthy lifestyle choices and a diet of lower nutritional quality.

4.2. Methodological considerations

Our study harbors several important strengths. This is the largest nested cross-sectional study to date to identify dietary patterns among Caucasian men. Indeed, other cross-sectional analyses nested within case-control studies included between 447 controls and 1475 controls (Randall et al., 1990; Ambrosini et al., 2008; Campbell et al., 2008; Chan et al., 2013), in comparison with 1636 men in our study. Although the participation rate was relatively good (56%), self-selection of study subjects might have compromised to some extent the generalization of findings to the base population *e.g.* French-speaking Montreal residents. Nevertheless, comparisons of participants and non-participants in our study based on census-derived variables indicated minimal differences between the two groups, alleviating concerns for selection bias. By comparison, Xu (2016) reported a median participation rate of 63% among population controls in 100 studies published in 1991–2000 and 53% in 46 studies published in 2001–2010. The median participation rate was 67% in 216 studies among North American population controls and 66% in 156 studies with in-person data collection such as ours.

Another strength of the study is the use of PCA to derive dietary patterns. Since dietary profiles of men in Montreal have never been reported, an *a posteriori* method or data-driven was the most appropriate approach to identify potentially new patterns. Moreover, as the number of study participants was very high, it was possible to perform PCA with a large number of components, namely 72 variables. Even if a large number of variables are used, the PCA alleviates collinearity issues between variables (Norman and Streiner, 2008). PCA enables the use of continuous variables, as derived from the FFQ, which reduces misclassification.

While potentially limiting the generalizability of findings to other populations, this approach enabled us to uncover patterns not previously described (Modified Western – Salty and Modified Western – Sweet), and will provide a useful basis when studying the role of diet in this population.

Dietary patterns were derived from a validated FFQ (Pan et al., 2004) with complementary questions focusing on the consumption of fat from meat, skin of poultry, blackened and barbecued meats, consumption of coffee, green tea, black tea, beer, wine, and spirits. This comprehensive dietary evaluation contributed to an explained variance of 15.6%, which compares well to that of other studies. While the food frequency questionnaire necessarily entailed some degree of misclassification, it is a superior method to food records to assess usual food habits (Willet, 1998). Finally, it is likely that some recall errors occurred given that the focus was 2 years before the interview.

In conclusion, our study of French-speaking men in Montreal identified three distinct dietary patterns, labelled as Healthy, Modified Western – Salty, and Modified Western – Sweet. While the former is commonly encountered in Western populations, the two others, highlighting a preference for salty foods or sweet foods, are novel. These dietary patterns have never been observed together in a study population. The next step will be to evaluate how these relate to prostate cancer risk in our study population, providing potential leads for prevention.

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Contributions

KT conducted the analysis, interpreted the results and prepared the manuscript. MEP designed and conducted the PROtEuS study. MEP, MCR and IC contributed to the interpretation of data and to the writing of the manuscript. All authors have read and approved the final version of the manuscript.

Competing interests

None to declare.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2018.12.017.

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