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Cohort profile: the CARTaGENE Cohort Nutrition Study (Quebec, Canada)

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ABSTRACT

Purpose To address emerging nutritional epidemiological research questions, data from contemporary cohorts are needed. CARTaGENE is the largest ongoing prospective cohort study of men and women in Québec, Canada. Dietary information was collected making it a rich resource for the exploration of diet in the aetiology of many health outcomes.

Participants CARTaGENE recruited over 43 000 men and women aged 40–69 in two phases (A and B). In phase A, a total of 19 784 men and women were enrolled between 2009 and 2010. In 2011–2012, phase A participants of CARTaGENE were recontacted and invited to complete the self-administered Canadian Diet History Questionnaire II, which assessed usual intake over the past 12 months of a comprehensive array of foods, beverages and supplements; 9379 participants with non-missing age and sex data and with plausible total energy intake comprise the CARTaGENE Cohort Nutrition Study (4212 men; 5167 women).

Findings to date Available dietary data include intake of total energy, macronutrients and micronutrients, food group equivalents and a measure of diet quality based on the Canadian Healthy Eating Index 2005 (C-HEI 2005). Intake and diet quality varied among participants though they generally met the recommended dietary reference intakes for most nutrients. The mean C-HEI 2005 score was 61.5 (SD=14.0; max score=100), comparable to the general Canadian population. The mean (SD) scores for men and women separately were 57.0 (14.1) and 65.2 (12.8), respectively. C-HEI scores were higher for never smokers (61.6), those who had attained more than a high school education (61.4) and those with high physical activity (60.4) compared with current smokers (55.8), less than high school education level (56.2) and low physical activity (57.6), respectively (p values<0.01).

Future plans The CARTaGENE Cohort Nutrition Study is an additional resource of the CARTaGENE platform and is available internationally to examine research questions related to diet and health among contemporary populations. Starting in 2024, annual diet assessments using two 24-hour dietary recalls over a 30-day period will take place, further expanding the cohort as a resource for dietary research.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ In 2011–2012, participants of CARTaGENE, Québec's largest prospective cohort study, were invited to complete the Canadian Diet History Questionnaire II, which assesses usual dietary intake and was developed using Canadian food intake and nutrient composition data.
⇒ A response rate of ~50% was obtained, which after data processing yielded the CARTaGENE Cohort Nutrition Study of 9379 participants (4212 men; 5167 women).
⇒ Diet quality, based on the Canadian Healthy Eating Index 2005, was calculated for each participant using national age-specific and sex-specific intake recommendations.

INTRODUCTION

Diet is recognised as an important determinant of health and chronic disease risk.[1] It is estimated that poor dietary habits account for more deaths globally than any other risk factor, including tobacco smoking.[2] In Canada, 34.2% of the population aged 20 years and older report having been diagnosed with at least one of the five major chronic diseases, including cardiovascular disease, cancer, chronic respiratory diseases, diabetes and mood and/or anxiety disorders, where four of these conditions (cardiovascular disease, cancer, chronic respiratory diseases and diabetes) accounted for 475.7 deaths per 100 000 in 2016.[3] Diet is well-established as a shared risk factor in the aetiology of these conditions with the exception of chronic respiratory diseases where the evidence is less clear.[4]

Prospective cohort studies have been an essential source of evidence supporting current knowledge of the role of diet on chronic disease.[5] However, given secular changes in the distribution of known chronic disease risk factors, such as smoking, obesity and hormonal exposures, the role of diet and other factors on health may also change which requires studies of new contemporary cohorts. The CARTaGENE cohort, established in 2010, is the largest ongoing prospective cohort study of men and women in the

predominantly French-speaking province of Québec in Canada.[6] It is also the largest source of objectively measured and self-reported health data in Québec combining detailed health information and standardised physical examinations with biomarker and genetic data to estimate the occurrence of chronic disease outcomes and their risk factors. Furthermore, continued follow-up of participants is conducted via web-based questionnaires and linkage to governmental health administrative databases enabling the collection of emerging risk factors and updates on health status as well as incident diseases. CARTaGENE is a participating regional cohort of the Canadian Partnership for Tomorrow's Health longitudinal cohort study[7] and was designed with the aim of harmonising with other Canadian and international cohorts.

To address new and emerging nutritional epidemiological research questions, additional research amassed in large contemporary international cohorts is required. Dietary information was collected in CARTaGENE participants making it a rich resource for the exploration of diet and its association with numerous health outcomes. In this article, we describe the participant selection, data collection and descriptive characteristics of the CARTaGENE Cohort Nutrition Study.

COHORT DESCRIPTION

Recruitment process for the nutrition study among CARTaGENE cohort participants

CARTaGENE is the province of Québec's largest ongoing prospective study of over 43 000 men and women aged 40–69 years at recruitment. It is a public research platform whose mission is to accelerate research and innovation in Québec and beyond. Recruitment of CARTaGENE participants was conducted in two phases (A and B). In phase A, a total of 19 784 men and women residing in the Greater Montréal area, Sherbrooke, Québec City and the Saguenay region were enrolled between August 2009 and October 2010.[6] In phase B, recruitment was expanded to include two other regions of Québec (Trois-Rivières and Gatineau), where ~23 000 additional men and women were recruited between 2012 and 2015.

In 2011–2012, phase A participants of CARTaGENE were recontacted and invited to complete the self-administered Canadian Diet History Questionnaire II (C-DHQ II), a food frequency questionnaire (FFQ) designed to estimate the usual intake of a wide array of nutrients and food groups over the past 12 months.[8] Participants were first contacted by phone or email in order to inform them about the nutrition survey and to solicit their preference for the mode of C-DHQ II completion, that is, by paper or web-based. Accordingly, participants received either paper versions of the consent form and questionnaire or web links to electronic versions. Up to five reminders were sent by email for the web-based questionnaires and two phone call reminders for the paper-based strategy over 3–5 weeks. A final response rate of ~50% was obtained (n=10 070). Written consent was obtained from all CARTaGENE participants.

Patient and public involvement

Neither patients nor the public were involved in the design or recruitment of the CARTaGENE Cohort Nutrition Study. Lay summaries of approved projects are shared with participants (and the public) through a section of the CARTaGENE website. Participants also receive annual newsletters and are invited to attend periodic webinars where research results are highlighted.

Data collection

At baseline, among all phase A CARTaGENE participants, anthropometric characteristics were directly measured by study staff while sociodemographic data (eg, education, household income, age, sex and language), lifestyle characteristics (eg, smoking, physical activity levels (measured with the International Physical Activity Questionnaire-short form[9])) and presence of chronic conditions ever diagnosed by a doctor were self-reported by participants. Chronic conditions included cancer, high blood pressure, diabetes, ulcerative colitis, Crohn's disease, angina, high cholesterol, heart attack, stroke, hepatitis and cirrhosis of the liver and were queried by 'Has a doctor ever told you that you had<<insert condition>>?'.[6]

Diet was collected using the self-administered C-DHQ II, which was designed using methods similar to the US-developed DHQ II, but based entirely on Canadian food intake and nutrient composition data to create an FFQ for use in Canada.[8] Food questions and portion sizes were based on food lists and nutrient values from the 24-hour dietary recall data collected in the Canadian Community Health Survey, Cycle 2.2, Nutrition (2004) (CCHS), Statistics Canada.[10] The C-DHQ II is comprised of 153 food and beverage questions, 11 questions for dietary supplements and 1 optional open-ended question to report other foods consumed at least once per month. Frequency of food intake is queried using 9 or 10 response options identifying the number of times per year, month, week or day depending on the item. In CARTaGENE, the past-year C-DHQ II paper and web versions were available in English and French. Participants completing the web version followed automated skip patterns and checks that ensured the completion of questions before proceeding to the next question. Otherwise, the content of the C-DHQ II paper and web versions were identical. The paper version was scanned using Teleform software (Autonomy Company; Vista, California, USA, User) for automated optical scanning and data capture. The web version infrastructure was designed and developed by the National Cancer Institute (Bethesda, Maryland, USA) and Information Management Systems (IMS) (Calverton, Maryland, USA). Data from both the paper and web versions were analysed using the Diet*Calc software (Canadian version, IMS, Calverton, Maryland, USA) to estimate individual-level mean daily intakes of energy and nutrients.

Data management

Information on male and female status was reported on the cohort baseline and C-DHQ II questionnaires; cross-tabulation across these two datasets revealed 91 participants that were discordant for male/female status. Since Diet*Calc-generated estimations of nutrient intakes and adequacy are based on male and female status, these 91 participants were not included in this analysis. Among the 9979 remaining participants, 125 participants did not begin the C-DHQ II and were also excluded. There were 203 participants who had filled out both the web and paper versions mostly due to the technical difficulties related to the web C-DHQ II. The forwith the most complete data was retained. All 9854 questionnaires were then processed through Diet*Calc which generated data on nutrient and food group intakes as well as total energy intake. Extreme outliers of total energy intake defined as values that fell outside the interval given by the 25th percentile minus twice the IQR to the 75th percentile plus twice the IQR[11] were identified leading to the exclusion of 458 questionnaires. As age and sex are important factors in health research and needed when considering dietary recommendations, 17 individuals with missing age were further excluded resulting in a final dietary dataset for 9379 individuals (4212 men and 5167 women).

Dietary data available in the CARTaGENE Cohort Nutrition Study

For each of the 9379 participants, intake of total energy and macronutrients and micronutrients are available directly from the Diet*Calc output (See Nutrient and Food Group List for C-DHQ II: https://epi.grants.cancer.gov/dhq2/database/nutrient.html#c-dhq). Select food group equivalent data were previously calculated and added to the C-DHQ II nutrient database,[12] and are thus also available from the Diet*Calc output. In addition, diet quality based on the Canadian Healthy Eating Index 2005 (C-HEI 2005)[13] is available, which was calculated using the added food group equivalent data. The C-HEI 2005[13] is a later adaptation of the US-developed HEI 2005.[14] The C-HEI 2005 scores measure adherence to the dietary recommendations of the 2007 Eating Well with Canada's Food Guide[15] and reflect the sum of the separate scores for adequacy and moderation components. Details on the calculation of the C-HEI 2005 have been described previously.[13] Scores for adequacy components are based on intake levels defined as sufficient for fruits and vegetables, whole fruits, dark green and orange vegetables, total grain products, whole grains, milk and alternatives, meat and alternatives and unsaturated fats while scores for moderation components are based on limiting intakes of saturated fats, sodium and 'other foods not recommended' in Canada's Food Guide.[13]

FINDINGS TO DATE

Men and women who participated in the nutrition survey ranged in age from 41 to 73 years (mean (SD) of 56.4 (7.8)) and the majority completed the C-DHQ II in French (92.3) and used the web version (74.2%) (table 1). Most participants were living with a partner (66.2%) had attained more than a high school education (77.0%) and had a household income of less than $75 000 (55.8%). In addition, most participants were not current smokers (84.4%) and engaged in moderate or high levels of physical activity (83.6%). The mean (SD) body mass index (BMI) of participants was 27.4 (5.3) kg/m^2 and 78% reported one or more diagnosed chronic conditions, the most common of which were high cholesterol (29.3%), high blood pressure (26.8%) and cancer (8.8%). In general, men were more likely to have a marital partner, a higher household income, currently smoke and have higher physical activity levels than women. The distributions of BMI, partner status, smoking, education, income, physical activity and the number of chronic conditions presented in table 1 are similar to that observed in the full CARTaGENE phase A cohort, previously published.[6] As described in the CARTaGENE cohort profile paper,[6] information on various domains, such as sociodemographic factors, mental health, psychosocial environment, disease history, healthcare/medication use and reproductive health, was collected and can be linked to the dietary data presented here. Readers are also directed to the CARTaGENE website for an exhaustive list of variables (www.cartagene.qc.ca).

Mean and median daily intake of total energy and selected nutrients from foods as well as whether men and women were meeting the dietary reference intakes (DRI), based on recommended dietary allowance (RDA) or adequate intake (AI) levels,[16] are described in table 2. The mean total energy intake was 1992 kcal for men and 1684 kcal for women. Differences by sex were also observed for other aspects of dietary intake. Overall, participants met the DRI for most nutrients except for fibre, vitamin D, total folate and sodium where generally less than 50% of men and women met the DRI. The lowest levels of intake were seen for vitamin D with a median of ~5 mcg/day for both men and women compared with the recommended intakes of ≥15 mcg/day.

The mean C-HEI 2005 score in the total population was 61.5 (SD: 14.0), ranging from 12.8 to 90.4 (maximum possible range 0–100) (table 3) and was lower in men than women (57.0 vs 65.2, respectively; p<0.01). When considering C-HEI 2005 components, mean scores were higher in women than men, except for total grain products, whole grains and saturated fats for which men and women had similar scores. In both women and men, the C-HEI 2005 components with the highest proportion of participants achieving maximum scores included total vegetables and fruits, whole fruits and unsaturated fats while the components of 'other foods' and whole grains had the lowest proportions of men and women achieving maximum scores.

Table 1 Selected baseline characteristics of CARTaGENE Cohort Nutrition Study participants

Selected characteristics	Overall N=9379	Men N=4212	Women N=5167
Mean age (SD), years	56.4 (7.8)	56.7 (7.9)	56.2 (7.7)
C-DHQ II mode, %			
Web	74.2	78.1	70.9
Paper	25.8	21.9	29.1
Questionnaire language, %			
French	92.3	91.9	92.6
English	7.7	8.1	7.4
Partner status*, %			
Partner	66.2	71.9	61.5
No partner	33.8	28.1	38.5
Highest education attainment†, %			
<High school	1.9	1.8	1.9
High school	21.1	19.8	22.2
>High school	77.0	78.4	75.9
Household income‡, %			
Less than $10 000	2.3	1.8	2.7
$10 000–$24 999	7.7	6.1	9.1
$25 000–$49 999	22.6	20.0	24.8
$50 000–$74 999	23.2	22.8	23.5
$75 000–$99 999	15.5	16.9	14.3
$100 000–$149 999	17.4	19.5	15.7
$150 000–$199 999	7.4	8.6	6.4
$200 000 and more	3.9	4.3	3.5
Smoking Status§, %			
Never	41.8	38.6	44.3
Former	42.6	45.0	40.7
Current	15.6	16.4	15.0
Physical activity¶, %			
High IPAQ score	44.0	49.4	39.7
Moderate IPAQ score	39.6	35.1	43.2
Low IPAQ score	16.4	15.5	17.1
Mean BMI (SD)**, kg/m^2	27.4 (5.3)	27.9 (4.7)	27.0 (5.7)
Number of chronic conditions††, %			
0	22.0	22.4	21.7
1	26.3	27.1	25.7
2+	51.7	50.5	52.6

*Partner status missing for 0.4% of participants.
†Educational attainment missing for 0.5% of participants.
‡Household income missing for 5.3% of participants.
§Smoking status missing for 0.4% of participants.
¶Physical activity score missing for 4.6% of participants. High IPAQ score: ≥3 days of vigorous activity and ≥1500 MET-min/week or any combination of walking, moderate or vigorous activity ≥7 days and ≥3000 MET-min/week; Moderate IPAQ score: ≥3 days of vigorous activity of at least 20 min/day or ≥5 days of moderate activity and/or walking for ≥30 min/day or ≥5 days of any combination of walking, moderate or vigorous activity of ≥600 MET-min/week. Low IPAQ score: No activity or some activity reported but not enough to meet moderate or high scores.
**BMI missing for 6% of participants.
††A self-reported physician diagnosis of one or more of the following: cancers, high blood pressure, diabetes, ulcerative colitis, Crohn's disease, angina, high cholesterol, heart attack, stroke, hepatitis, cirrhosis of the liver. Missing information for 0.1% participants.
BMI, body mass index; C-DHQ II, Canadian Diet History Questionnaire II; IPAQ, International Physical Activity Questionnaire.

C-HEI 2005 scores varied according to some sociodemographic and lifestyle variables and number of chronic conditions (table 4). In particular, mean C-HEI 2005 scores were 2.8–6.3 points higher for never smokers, those who had attained at least a high school education and those with a high physical activity score (compared with current smokers, those with less than high school education level and those with low physical activity, respectively) for all participants and for men and women separately. Among men, C-HEI 2005 scores were also higher among those who completed the questionnaire in English versus French, those with the lowest household income levels and those with less than two chronic conditions. C-HEI 2005 scores did not vary by language, income and number of chronic conditions among women. Similarly, C-HEI 2005 scores did not vary by partner status or BMI, as a continuous variable, for both men and women. For each increasing year of age, the C-HEI 2005 score increased by 0.14 for men and 0.09 for women.

STRENGTHS AND LIMITATIONS

The CARTaGENE Cohort Nutrition Study provides the opportunity to examine research questions related to diet among a contemporary population of 9379 men and women with comprehensive data on usual daily intake of nutrients, food groups and diet quality. The dietary data along with other questionnaire data, physical measures and biospecimens makes the CARTaGENE Cohort Nutrition Study one of the richest resources available for dietary studies in Canada. Indeed, these dietary data have already been used in reports on subsets of the CARTaGENE population.[17–20] The present profile provides the first descriptive analysis of the dietary profile for all CARTaGENE participants with complete dietary data.

The diet data are based on responses to the C-DHQ II, which was developed using entirely Canada-specific food intake and nutrient composition data.[10] Like all FFQs, the C-DHQ II has a finite food list that limits the ability to capture all foods consumed by participants. However, by using the most recent national intake data at the time[10] along with consultation with researchers and Health Canada collaborators with access to market data, the most commonly consumed foods including items newly available up to 2010 were included on the C-DHQ II.[8] Furthermore, the C-DHQ II was completed by CARTaGENE Cohort Nutrition Study participants in French or English according to the participants' language of choice, which potentially reduces dietary measurement error versus another FFQ.

The nutrition study participants met the RDA and AI levels for the majority of nutrients, but nonetheless had a wide variation in their intake of various macronutrients and micronutrients, their total energy intake and their C-HEI 2005 scores, which will facilitate future analyses of important topics in nutritional epidemiology. The observed mean C-HEI of 61.5 is comparable to the score of 58.8 reported previously in the CCHS (Cycle 2.2).[13] In the CCHS

Table 2 Descriptive summaries for daily energy and nutrient intakes from foods and comparisons with available dietary reference intakes (RDA or AI), in the CARTaGENE Cohort Nutrition Study

	Dietary reference intakes (DRI)	Men (N=4212)			Women (N=5167)		
		% meeting DRI	Mean (SD)	Median (IQR)	% meeting DRI	Mean (SD)	Median (IQR)
Total energy (kcal)	Not applicable	–	1991.9 (1074.0)	1872.3 (1230.1)	–	1684.3 (748.7)	1603.7 (865.2)
% energy total fat	AI: Between 25 and ≤35%	45.4	30.4 (9.5)	32.2 (10.1)	49.7	31.8 (7.8)	32.8 (8.6)
% energy carbohydrates	AI: Between 45 and ≤65%	60.4	50.5 (10.7)	48.9 (11.8)	67.5	51.6 (9.7)	50.3 (11.1)
% energy protein	AI: Between 10 and ≤35%	89.0	14.9 (4.0)	15.3 (4.3)	94.0	15.8 (3.6)	15.9 (4.2)
Carbohydrate (g)	RDA: >130	82.3	243.9 (134.5)	223.8 (150.5)	82.6	213.8 (100.0)	198.3 (110.0)
Sugar (g)	Not applicable	-	110.4 (73.0)	95.4 (69.5)	-	102.8 (56.7)	91.8 (57.4)
Dietary fibre (g)	RDA: Men: >30; RDA: Women: >21	15.0	19.4 (11.5)	17.8 (13.6)	37.3	19.7 (10.5)	18.0 (11.8)
Total fat (g)	Not determinable	–	70.7 (43.6)	67.0 (51.5)	–	61.3 (32.4)	58.0 (38.0)
Saturated fat (g)	AI: As low as possible while consuming a nutritionally adequate diet	–	23.0 (14.6)	21.5 (17.2)	–	19.7 (11.3)	18.3 (12.7)
Monounsaturated fat (g)	Not available	–	28.6 (18.2)	27.1 (21.7)	–	24.5 (13.3)	23.2 (15.7)
Polyunsaturated fat (g)	Not available	–	13.1 (8.7)	12.0 (10.3)	–	11.6 (7.0)	10.7 (7.7)
Protein (g)	AI: Men: ≥56 AI: Women: ≥46	66.6	76.6 (45.3)	72.7 (53.9)	73.2	67.7 (34.6)	64.2 (40.9)
Cholesterol (g)	AI: As low as possible while consuming a nutritionally adequate diet	–	233.5 (157.3)	219.2 (193.7)	–	192.3 (112.5)	180.9 (132.1)
Sodium (mg)	AI: <2300 mg/day	39.3	2831.0 (1714.9)	2661.0 (1910.9)	50.0	2420.9 (1196.1)	2299.4 (1391.3)
Alcohol (g)	Not available	–	17.6 (40.2)	8.5 (17.6)	–	7.6 (13.5)	4.0 (9.0)
Caffeine (mg)	Not available	–	306.7 (237.5)	299.8 (287.8)	–	267.4 (210.1)	206.6 (287.2)
Iron (mg)	RDA: ≥8	77.6	13.6 (7.4)	13.1 (9.1)	78.8	12.6 (6.3)	11.9 (7.1)
Calcium (mg)	RDA: Men: ≥1000 RDA: Women: ≥1000 (31–50 years) ≥1200 (51–70 years)	40.7	1013.2 (661.1)	876.4 (675.5)	86.9	1033.3 (632.1)	911.8 (634.3)
Vitamin D (mcg)	RDA: ≥15	5.6	6.3 (5.2)	5.1 (5.1)	3.9	6.0 (4.6)	5.0 (4.3)
Total folate (mcg)	RDA: ≥400	38.9	382.6 (228.9)	347.7 (254.1)	35.9	383.4 (227.0)	341.4 (219.4)
Vitamin B12 (mcg)	RDA: ≥2.4	77.3	5.2 (4.6)	4.3 (4.1)	76.7	5.0 (5.3)	3.8 (3.3)

AI, adequate intake; RDA, recommended dietary allowance.

Table 3 Average C-HEI 2005 and component scores of men and women in the CARTaGENE Cohort Nutrition Study

Component	Range of scores	Scoring criteria*	All participants (N=9379)		Men (N=4212)		Women (N=5167)	
			Mean (SD)	% with max score	Mean (SD)	% with max score	Mean (SD)	% with max score
Overall C-HEI 2005	0–100		61.5 (14.0)	–	57.0 (14.1)	-	65.2 (12.8)	-
Adequacy†	0–60							
Total vegetables and fruit	0–10	Min: 0 Max: 4–10 servings	7.8 (2.6)	42.7	7.5 (2.8)	38.3	8.1 (2.4)	46.2
Whole fruit	0–5	Min: 0 Max: 0.8–2.1 servings (21% of recommendations for total vegetables and fruit)	4.0 (1.5)	57.9	3.7 (1.7)	48.4	4.3 (1.3)	65.7
Dark green and orange vegetables	0–5	Min: 0 Max: 0.8–2.1 servings (21% of recommendations for total vegetables and fruit)	3.3 (1.8)	38.4	3.0 (1.8)	31.8	3.6 (1.6)	43.8
Total grain products	0–5	Min: 0 Max: 3–8 servings	2.4 (1.5)	8.9	2.4 (1.5)	10.3	2.4 (1.4)	7.7
Whole grains	0–5	Min: 0 Max: 1.5–4 servings (50% of recommendation for total grain products)	0.9 (1.2)	2.8	1.0 (1.3)	3.9	0.9 (1.0)	1.9
Milk and alternatives	0–10	Min: 0 Max: 2–4 servings	5.4 (3.2)	19.3	5.2 (3.3)	18.2	5.6 (3.2)	20.2
Meat and alternatives	0–10	Min: 0 Max: 1–3 servings (75–225 g)	6.3 (3.4)	26.7	5.7 (3.4)	19.5	6.9 (3.3)	32.6
Unsaturated fats	0 –10	Min: 0 Max: 30–45 g	8.0 (2.9)	50.9	7.3 (3.2)	39.9	8.5 (2.5)	59.8
Moderation‡	0–40							
Saturated fats	8–10 0–8	7% to 10% of total energy intake 10% to≥15% of total energy intake	6.7 (3.0)	14.6	6.7 (3.0)	15.9	6.6 (3.1)	13.5
Sodium	8–10 0–8	<AI level to tolerable upper intake (TUI) level TUI level to 2 x TUI level	6.5 (3.2)	13.8	6 (3.5)	15.0	7.0 (2.9)	12.8
Other food	0–20	Min: ≤5% of total energy intake Max: ≥40% of total energy intake	10.2 (5.7)	2.3	8.7 (5.8)	1.9	11.4 (5.4)	2.6

*According to age and sex, as specified in Canada's Food Guide.
†For adequacy components, 0 point for minimum or less, 5 or 10 maximum or more and proportional for amounts between minimum and maximum.
‡For moderation components, 10 or 20 points for minimum or less, 0 points for maximum or more and proportionally between minimum and maximum.
C-HEI, Canadian Healthy Eating Index.

population aged 51–70 years, C-HEI scores were higher in women (61.3) than men (57.7), which was a pattern also observed in CARTaGENE. That the C-HEI 2005 scores in CARTaGENE were higher among never versus current smokers, those with high school or greater education versus less than high school and those with a high versus low physical activity score in both men and women, as would be expected, provides support in the utility of the CARTaGENE Cohort Nutrition Study in future studies of diet and health.

A potential limitation is that only 50% of all CARTaGENE phase A participants completed the nutrition

Table 4 Variations in C-HEI 2005 scores by sociodemographic and lifestyle characteristics and number of chronic conditions in the CARTaGENE Cohort Nutrition Study

Selected characteristics	Overall (N=7981)*		Men (N=3571)*		Women (N=4410)*	
	Association with HEI†	P value‡	Association with HEI†	P value‡	Association with HEI†	P value‡
Age (continuous, years)	0.09	<0.01	0.14	<0.01	0.09	<0.01
BMI (continuous, kg/m^2)	−0.14	<0.01	−0.05	0.33	−0.05	0.18
Marital status		0.08		0.12		0.36
Partner	59.4		54.7		62.6	
No partner	58.7		55.5		62.2	
Smoking status		<0.01		<0.01		<0.01
Never	61.6		57.9		64.2	
Former	59.8		55.8		63.1	
Current	55.8		51.6		60.0	
Questionnaire language		0.04		<0.01		0.59
French	58.5		53.9		62.2	
English	59.7		56.3		62.6	
Highest education attainment		<0.01		0.01		<0.01
Less than high school	56.2		52.5		59.6	
High school	59.6		55.7		62.6	
>High school	61.4		57.0		65.1	
Household income, $		<0.01		0.06		0.50
Less than $10 000	59.2		56.1		61.3	
$10 000–$24 999	61.2		57.9		63.1	
$25 000–$49 999	59.2		54.7		62.2	
$50 000–$74 999	59.5		55.1		62.9	
$75 000–$99 999	58.7		54.9		62.2	
$100 000–$149 999	58.5		55.0		61.9	
$150 000–$199 999	58.2		53.7		63.0	
$200 000 and more	58.0		53.2		63.8	
Physical activity		<0.01		<0.01		<0.01
High IPAQ score	60.4		57.5		63.8	
Moderate IPAQ score	59.3		54.5		62.6	
Low IPAQ score	57.6		53.3		60.9	
Number of chronic conditions		0.32		0.02		0.12
0	59.3		56.0		62.3	
1	59.2		55.0		63.0	
2+	58.7		54.3		62.0	

*Analyses included those with complete data on all selected characteristics; there was missing data for 1398 in the total population; 641 men and 757 women.
†Associations represent variations in C-HEI scores according to variations in each of the characteristics, where β coefficients for continuous variables and means for categorical variables were estimated using multiple linear regression.
‡P value for the characteristic in the multiple linear regression model.
BMI, body mass index; C-HEI, Canadian Healthy Eating Index; IPAQ, International Physical Activity Questionnaire.

study. However, similar sociodemographic characteristics have been reported for the full phase A cohort[6] as for the CARTaGENE Cohort Nutrition Study providing evidence to support its representativeness. Moreover, in studies aimed at examining dietary exposures in relation to health outcomes, observed associations considered to be internally valid estimates of effect may be more widely generalisable.[21]

Another potential concern is that the C-DHQ II data in the CARTaGENE Cohort Nutrition Study was collected using two modalities (ie, paper and web). However, a comparison of the presented findings using paper versus web versions of the C-DHQ II did not reveal any notable differences between the two modalities either in the C-HEI 2005 scores or in score variations according to sociodemographic and

lifestyle characteristics (data not shown). A recent study using the C-DHQ II in an independent population in another Canadian province concluded that paper and web-based questionnaires may be combined because both were highly reliable.[22]

COLLABORATION

As mentioned, CARTaGENE is a public research platform and the comprehensive dietary data reported in the CARTaGENE Cohort Nutrition Study are included in this platform (www.cartagene.qc.ca). Only one other regional cohort of the Canadian Partnership for Tomorrow's Health study,[7] the Alberta's Tomorrow Project,[23–25] has also collected comprehensive dietary intake data. These baseline data are key to maintaining the correct temporal order between dietary exposures of interest and the majority of subsequent outcomes that have already occurred in this cohort and will be studied in etiological studies.

The linking of dietary data in the CARTaGENE Cohort Nutrition Study with other detailed health, biomarker and genetic data will allow the study of diet and its association with numerous outcomes. Participants have consented to the use of their data internationally with access policies in place. Of note, starting in 2024, annual diet assessments using two 24 hours dietary recalls over a 30-day period will be administered in collaboration with NutriQuébec[26] (Université Laval), further expanding on the strengths of the cohort as a resource for dietary studies. Additional details on data access may be obtained at https://cartagene.qc.ca/en/researchers/access-request.html. Researchers are encouraged to submit project proposals on diet and health using CARTaGENE data.

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Data availability statement Data may be obtained from a third party and are not publicly available. The data that support the findings of this study are available from CARTaGENE (https://cartagene.qc.ca/). Please see the 'Collaboration' section of this article for information on how to access this data. Scripts used in the analyses presented here are available from the authors upon reasonable request and with permission of CARTaGENE.

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