Fruit and Vegetable Consumption Is Lower and Saturated Fat Intake Is Higher among Canadians Reporting Smoking[1]

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ABSTRACT Understanding differences in dietary patterns by smoking status is important for nutritionists and health educators involved in helping individuals to make healthy dietary and lifestyle choices. Although smokers have a poor quality diet compared with nonsmokers, no study has examined nutritional adequacy and variability in the nutrient intake of smokers. The aim of this study was to compare dietary habits of smokers with nonsmokers in terms of nutrient intake, food groups contributing to nutrient intake, nutritional adequacy and day-to-day variation in nutrient intake. Noninstitutionalized adults aged 18–65 y (n = 1543) who participated in the Food Habits of Canadians Survey (1997–1998) were studied. Subjects, selected from across Canada using a multistage, random-sampling strategy, completed an in-home 24-h dietary recall. Repeat interviews were conducted in a subsample to estimate variability in nutrient intake. Smokers had higher intakes of total and saturated fat, and lower intakes of folate, vitamin C and fiber than nonsmokers. There were no significant differences in calcium, zinc and vitamin A intakes or day-to-day variation in nutrient intake by smoking status. Smokers consumed significantly fewer fruits and vegetables than nonsmokers, leading to lower intakes of folate and vitamin C. In conclusion, smokers have a less healthy diet than nonsmokers, placing them at higher risk for chronic disease as a result of both dietary and smoking habits. Diet may act as a confounder in smoking-disease relationships. J. Nutr. 131: 1952–1958, 2001.

KEY WORDS: • *smokers and nonsmokers* • *nutrient intake* • *food groups* • *supplement use* • *humans*

Smoking is a major risk factor for cardiovascular disease, respiratory disease and cancer (1). It has been postulated that the increased risk for these diseases among those who smoke compared with those who do not smoke may be due in part to differences in other lifestyle behaviors, including dietary habits (2). In the second National Health and Nutrition Examination Survey (NHANES II),[3] people who smoke reported lower intakes of vitamin C, folate, fiber and vitamin A than those who do not smoke (3). People who report smoking also tend to have higher intakes of saturated fatty acids and lower intakes of polyunsaturated fat, iron, β-carotene and vitamin E compared with people who do not smoke (4–8); in addition, they tend to differ in the way they select their food. They are more likely to choose white bread, sugar, meat, butter, whole milk and eggs and less likely to consume whole-wheat bread, high fiber breakfast cereals, fruits and vegetables than nonsmokers (9,10). In addition to a poorer diet, people who smoke are also exposed to free radicals, produced by cigarette smoke, which could provoke lipid peroxidation in cell membranes (1,11,12). Several studies have shown that micronutrients such as vitamin A, particularly β-carotene, vitamin C, vitamin E, folic acid and phenolic compounds derived from fruits and vegetables have protective effects against cigarette smoke–induced toxicity by preventing lipid peroxidation (1,13). Because those who smoke have low intakes of fruits and vegetables that are rich in antioxidants, they are more likely to be susceptible to oxidative damage caused by free radicals.

Indeed, people who smoke have a poor quality diet in terms of nutrient intakes and food choices. There is, however, a lack of data on nutritional adequacy and variability in nutrient intake among people who smoke. Examination of the main food group contributors to nutrient intake (for example, folate, vitamin C) by smoking status will provide insight on food choices responsible for differences in nutrient intake. Also, few studies that have examined smoking and diet have controlled for socioeconomic status.

Data used in the study are from the Food Habits of Canadians Survey conducted in 1997–1998, which is the most recent national nutrition survey in Canada (14). The aim of this study was to assess how dietary habits of those who smoke differ from those who do not smoke in terms of nutrient

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[3] Abbreviations used: AI, adequate intake; BMI, body mass index; BMR, basal metabolic rate; EAR, estimated average requirements; EI, energy intake; NHANES, National Health and Nutrition Examination Survey; RE, retinol equivalents.

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intake, contribution of food groups to nutrient intake, nutritional adequacy and within-subject variability in nutrient intake.

SUBJECTS AND METHODS

A sample of 1543 noninstitutionalized adults aged 18–65 y was randomly selected from five regions of Canada, including the Atlantic Provinces, Quebec, Ontario, the Prairie provinces and British Columbia, using a multistage, random-sampling strategy (14). The Canadian population living in more remote regions (15%) was not sampled due to cost considerations. In each region studied, four census divisions were randomly selected with the probability of selection being proportional to the size of the population. This yielded 20 census divisions across the country. Two subdivisions were randomly selected within each census division, and two enumeration areas were selected within each subdivision, yielding 80 enumeration areas. Within each enumeration area a random sample of households was drawn from the 1996 computerized telephone listings of residential homes in each area (Pro-CD, Mass, Canada). Letters were sent to inform household occupants of the survey and to invite the participation of the adult member in the household with the next upcoming birthday. The letter was followed by a telephone call from a dietitian-interviewer to arrange a face-to-face interview. The criteria for exclusion included pregnancy and lactation, and inability to speak English or French. The final sample included 572 men and 971 women. Approximately 17% of potential subjects could not be contacted; 57% refused to participate, resulting in an average response rate of 26%. Survey data were compared with the 1991 Census data (15). The sociodemographic profile of the study sample was found to be comparable to that of the general Canadian population (number of people born in Canada: 86 vs. 84%; number of subjects with less than high school education: 22 vs. 26%; and single marital status: 26 vs. 32%, respectively) (14). In addition, the percentage of adults reporting a body mass index (BMI) of >27 kg/m^2 was 32% in our study and 31% in the National Population Health Survey (15). The percentage of adults (>18 y of age) reporting smoking in our study was 20% and in the Canadian Tobacco Use Monitoring Survey was 28% (16). A repeat interview was conducted in a systematic sample of 22% of subjects to estimate within-subject variability in nutrient intake.

Self-reported height, weight, smoking status and educational level were collected. Subjects who answered yes to the question "Do you smoke >5 cigarettes per day?" were categorized as smokers; all others were categorized as nonsmokers. This level was chosen as the cut-off point to determine smoking status because it is difficult to categorize the small number of people who smoke very little. The average number of cigarettes used by smokers is 19 cigarettes/d in Canada (16). Three levels of education included the following: *1*) high school (Grade 11) or less; *2*) preuniversity (2-y program) or trade school; and *3*) a university degree. Education was used as an indicator of socioeconomic status.

Dietary intake was recorded by the dietitians using the 24-h recall method (17). Detailed descriptions of all foods, beverages and supplements consumed during the 24-h period before the interview, including the quantity, cooking method and brand names were recorded. Quantities were estimated using standard graduated glasses, bowls, spoons and a ruler. Quality control was ensured during dietary data collection and entry to minimize error and increase reliability (18). Dietitians were trained to use research forms, tools, and a food and nutrient database that were used for coding. Furthermore, they resided in the regions surveyed, ensuring familiarity with the local food supply and food preparation methods. An adapted multiple-pass technique was employed (19); the subjects were first asked to recall their food intake over the previous 24-h period, followed by probing for detailed descriptions of food, beverages and supplements including food portion sizes, and then by a review of intake and clarifications.

Nutrient intakes were entered, double verified by another person and analyzed using the Candat nutrient analysis program (Godin London, London, Canada) and the 1997 Canadian Nutrient File. Approximately 270 food items were added to the database, because they were not available on the Canadian Nutrient File. Nutrient information was obtained from food manufacturers' data when possible or from the American database (20). The nutrient database includes >5000 food items and 40 nutrients. Folic acid supplementation of flour in Canada occurred after the data collection.

Foods were classified into 51 food groups for the purposes of describing types of foods in the following manner: fruits were classified as citrus and noncitrus fruits (due to differences in vitamin C content). Vegetables were categorized according to specific nutrient contribution by each subgroup (lettuce/cabbage/greens, other dark green vegetables, dark yellow/orange vegetables, tomatoes, potatoes and non-dark green vegetables). Dairy products were grouped as milk, cheese, yogurt, cream and ice cream/pudding. The meat group was classified according to the type of meat (beef, pork, poultry, bacon/sausages/lunchmeats, fish/seafood, organ meats, lamb and other meats). Grain products were categorized as breads, pasta/rice/grains, cereals and mixed dishes. The alcohol group included beer, alcoholic coolers, liquor and wine. Other foods were broken into clear categories such as sugar/syrup/gelatin, carbonated beverages, candies/chocolates. These food groups were used to determine the main contributors to nutrient intake (carbohydrate, fat, folate and vitamin C) by smoking status. The percentage of subjects consuming the food on the day of the intake and the average amount of that food eaten by consumers were analyzed and compared using χ^2 and *t* tests.

To determine whether subjects in the two smoking categories met the recommendations for food groups based on Canada's Food Guide to Healthy Eating (21), foods were categorized into the following food groups: grains, dairy, meat, and fruits and vegetables. Food portions were determined using food density (g/mL), and all foods with very similar densities within a category were divided by the same weight of a standard portion size to obtain units of portion size (e.g., cooked rice or pasta = 70 g in the grain products food group; corn/other vegetables = 85 g in the vegetables and fruit group). In addition, the Good Health Eating Guide Resource (22) was consulted to determine weights for some foods and also to establish how many portions of each food group went into each of the mixed foods. Mixed food groups were broken down into constituents for contribution to the four food groups (e.g., one cheese pizza = 1 grain product and 0.2 milk product).

Data were collected on supplement use on the day of the recall. Supplement composition was determined using the Health Canada Drug Product Database (23), product labels or by contacting the company. When adequate information was not available to identify brand or amount of nutrient present in the supplement, default values were assigned on the basis of the modal value for the supplement. For vitamin B complex preparations, the lowest values found in any identified supplements were used.

Nutrients examined in this analysis include calcium (mg), iron (mg), zinc (mg), folate (μg), vitamin A [retinol equivalents (RE)], vitamin C (mg) and fiber (g) as well as total fat, saturated fat, monounsaturated fat and alcohol, which are expressed as percentage of energy. Carotenoid data are not available in the Canadian Nutrient file. These nutrients were chosen because the mean percentage of energy from fat and saturated fat are generally above the Nutrition Recommendations of 30 and 10%, respectively (24); vitamin C is a nutrient of concern for those who smoke (25), whereas calcium, iron and folate are often below recommended levels in Canadians (14,24,26). Zinc was also assessed because of its role in limiting free radical–induced oxidative damage (27).

The distribution of each nutrient was examined for normality, and appropriate transformations (log and square root) were performed for nutrients with skewed distributions (28). However, an appropriate transformation was not found for alcohol. Using the subsample with 2 d of intake, inter- (between) and intra- (within) subject variability were estimated separately for men and women by ANOVA (29). Using this measure of variation, the entire study population distribution was adjusted for within-subject variability using the NRC method (30). Differences in nutrient intake by smoking status were assessed separately for men and women using the general linear method of ANOVA, adjusting for education. Multiple comparisons were corrected for using Scheffé's method (29). Possible effect modification by level of education and age was examined by including interaction terms for smoking and education and smoking and age.

A comparison of the day-to-day variability between people who

TABLE 1

Demographic characteristics of subjects by smoking status

	Men (n = 571)		Women (n = 970)	
	Smokers (n = 127)	Nonsmokers (n = 444)	Smokers (n = 181)	Nonsmokers (n = 789)
Age,[1] *y*	42 ± 11	44 ± 11	44 ± 10	44 ± 11
Education level,[2] *n (%)*				
≤High school	67 (53%)	154 (35%)	106 (59%)	340 (43%)
Preuniversity/ Trade	29 (23%)	106 (24%)	45 (25%)	206 (26%)
University	31 (24%)	184 (41%)	30 (16%)	243 (31%)
BMI,[1] *kg/m2*	26.4 ± 4.3	26.8 ± 4.0	24.9 ± 4.6	25.5 ± 5.1

[1] Values are means ± SD.
[2] P = 0.001 (χ^2 analysis).

smoked and people who do not smoke was examined by computing intra- (within) to inter- (between) subject variability ratio for energy, calcium (mg), folate (μg), vitamin A (RE), vitamin C (mg), zinc (mg) and iron (mg).

The percentage meeting the National Academy of Science Recommendations for calcium (adequate intake, AI), iron, zinc, folate and vitamin C (estimated average requirement, EAR) was examined (25,31–33) by smoking status.

To assess underreporting of food intake, the ratio of reported energy intake (EI) to estimated energy requirements (estimated basal metabolic rate, BMR_{est}) was calculated separately for men and women by smoking status. BMR was calculated from the reported height and weight using the FAO/WHO/UNU formula (34) and is reported as $BMR_{est.}$ All analyses were performed using SAS (version 6.12, Cary, NC)

RESULTS

There were no significant differences by smoking status in age or BMI among men and women. However, those who smoked had less education than those who did not smoke ($P < 0.001$) (**Table 1**).

Total energy intake did not differ by smoking status (**Table 2**). However, people reporting smoking consumed more total fat and saturated fat and significantly less folate, vitamin C and fiber than those who did not report smoking. There were no significant differences in calcium, zinc or vitamin A intakes by smoking status. Although most patterns of intake were very similar in men and women, men who smoked consumed more monounsaturated fat and women who smoked consumed less iron than people who did not smoke. The percentage of subjects consuming alcohol did not differ between the two smoking groups. Alcohol consumption among women who reported drinking alcohol was higher in those who reported smoking (Wilcoxon test, $P < 0.01$). There was no interaction of smoking by education level on nutrient intake. There were no interactions by age and smoking status for most nutrients with the exception of folate intake, which was higher among nonsmoking women in the 35–49 and 50–65 y age groups; among young women, however, there was no association of smoking status with folate intake.

The mean EI/BMR_{est} for men who smoked and did not smoke was 1.44 ± 0.61 and 1.44 ± 0.58, respectively, indicating little if any underreporting. The mean EI/BMR_{est} for females who smoked vs. those who did not smoke was 1.23 ± 0.62 vs. 1.28 ± 0.53, respectively, indicating underreporting in both groups. The EI/BMR_{est} ratio was similar across BMI categories (<20, ≥20–25, ≥25-<27 and ≥27 kg/m^2).

Food groups. Food choices differed by smoking status (**Table 3**). Because men and women reported similar food group choices contributing to carbohydrate, fat, vitamin C and folate intakes, results are reported by smoking status alone. The order in which foods appear in the table is the order in which each food contributed to the overall nutrient intake of the study sample. The frequency of consumption on the day of recall and mean intake of each food by the consumers of that food are reported. The differences in food group intake for primary sources of carbohydrate indicated that those who did not smoke were more likely to consume pasta, cakes/cookies, noncitrus fruits, cereals and milk. The portion sizes of cereals were larger for smokers. Other differences were apparent in food sources of folate and vitamin C, indicating better food choices among people who do not smoke. Although, overall, the most important contributors to folate and vitamin C were fruits and vegetables in both groups, significantly fewer smokers reported consuming different categories of fruits and veg-

TABLE 2

Nutrient intakes stratified by men and women smoking status[1,2]

	Men (n = 571)		Women (n = 970)	
Nutrient	Smokers (n = 127)	Nonsmokers (n = 444)	Smokers (n = 181)	Nonsmokers (n = 789)
Energy, *kcal*	2544 ± 810	2562 ± 826	1650 ± 541	1726 ± 463
kJ	10,634 ± 3386	10,709 ± 3453	6897 ± 2261	7215 ± 1935
Total fat, *% of total energy*	31.2 ± 7.09	29.5 ± 6.68*	29.5 ± 6.70	28.5 ± 5.90*
Saturated fat, *% of total energy*	10.3 ± 3.10	9.39 ± 2.87*	9.85 ± 2.95	9.09 ± 2.69*
Monounsaturated fat, *% of total energy*	12.1 ± 3.06	11.3 ± 3.32*	11.0 ± 2.99	10.6 ± 2.57
Calcium, *mg/d*	943 ± 491	976 ± 517	693 ± 346	733 ± 334
Iron, *mg/d*	16.9 ± 6.73	18.0 ± 6.16	11.6 ± 4.59	12.6 ± 3.85*
Zinc, *mg/d*	13.6 ± 6.52	13.4 ± 4.95	9.23 ± 5.18	9.30 ± 3.74
Folate, *μg/d*	254 ± 108	299 ± 130*	197 ± 112	225 ± 91*
Vitamin A,[3] *RE/d*	1622 ± 968	1745 ± 1115	1601 ± 1923	1971 ± 1953
Vitamin C, *mg/d*	120 ± 107	152 ± 117*	95 ± 79	130 ± 87*
Fiber, *g/d*	13.7 ± 6.43	17.5 ± 8.76*	11.5 ± 6.92	14.0 ± 6.87*

[1] Values are means ± SD (adjusted for within-subject variability by sex).
[2] $P \leq 0.05$ (comparison of smokers vs. nonsmokers stratified by sex, ANOVA with Scheffé's test).
[3] RE, retinol equivalents.

TABLE 3

Food groups contributing to intakes of carbohydrate, fat, folate and vitamin C by smokers and nonsmokers[1]

	Smokers (n = 308)			Nonsmokers (n = 1233)		
Nutrient	Food group	Freq[2]	Amount[3]	Food group	Freq[2]	Amount[3]
		%	g/d		%	g/d
Carbohydrate	Breads	87.3	98.1 ± 72.8	Breads	86.6	110.0 ± 78.0*
	Carbonated beverages	42.9	720.1 ± 540.6	Pasta/rice/grains	40.6**	231.4 ± 215.4
	Sugar/syrups/jams/ gelatin/cocoa mixes	61.7	45.8 ± 119.9	Cakes/cookies/pies/ granola bars	48.1**	81.6 ± 86.8
	Pasta/rice/grains	27.0	227.2 ± 173.2	Noncitrus fruits	60.0**	191.8 ± 162.3
	Cakes/cookies/pies/ granola bars	38.6	77.1 ± 81.6	Cereals	36.9**	85.0 ± 94.4*
	Potatoes boiled/mashed	29.2	198.1 ± 149.6	Carbonated beverages	36.7*	525.2 ± 350.6***
	Milk/chocolate milk	70.5	326.6 ± 322.4	Milk/chocolate milk	78.8**	299.0 ± 333.2
	Cereals	22.7	114.8 ± 134.5	Potatoes boiled/mashed	28.2	200.7 ± 165.1
Fat	Beef/Veal	32.5	153.0 ± 127.3	Cakes/cookies/pies/ granola bars	48.1**	81.6 ± 86.8
	Margarine/butter/ lard	63.6	12.6 ± 16.5	Breads	86.6	98.2 ± 73.0*
	Cheese	38.6	77.1 ± 73.7	Margarine/butter/lard	57.6	11.5 ± 31.3
	Sausages/bacon/ lunch meats	32.5	153.0 ± 127.3	Beef/veal	27.5	133.9 ± 118.4
	Breads	87.3	110.0 ± 78.0	Cheese	48.1**	81.6 ± 86.8
	Cakes/cookies/pies/ granola bars	38.6	77.1 ± 73.7	Sausages/lunchmeat/ bacon	27.5	133.9 ± 118.4
	Milk/chocolate milk	70.5	326.6 ± 322.4	Mixed meat/poultry/ fish dishes	15.9	223.3 ± 220.2
	Mixed meat/poultry/ fish dishes	15.6	183.0 ± 134.5	Milk/chocolate milk	78.8*	299.0 ± 333.2
Folate	Breads	87.3	98.2 ± 72.8*	Citrus fruit juice	35.4**	300.0 ± 231.1
	Lettuce/greens/cabbage	30.5	87.1 ± 101.6	Lettuce/greens/cabbage	38.9*	81.0 ± 82.8
	Citrus fruit juice	22.1	315.2 ± 300.0	Breads	86.6	109.7 ± 78.0
	Other non-dark green vegetables	52.9	90.0 ± 120.5	Other non-dark green vegetables	63.3**	83.0 ± 88.8
	Hamburger/pizzas	9.74	224.8 ± 219.2*	Legumes/nuts/seeds	28.1*	45.6 ± 66.7
	Milk/chocolate milk	70.5	326.6 ± 322.4	Other dark green vegetables	32.5*	69.6 ± 70.8
	Coffee/Tea	87.3**	1106.7 ± 905.5*	Milk/chocolate milk	78.8**	299.0 ± 333.2
	Tomatoes/juice/sauce	38.6	147.0 ± 166.8	Noncitrus fruits	28.1*	45.6 ± 66.8
Vitamin C	Citrus fruit juice	22.1	315.2 ± 256.8	Citrus fruit juice	35.4**	299.8 ± 230.1
	Citrus fruits	10.7	214.0 ± 142.1	Citrus fruits	20.2**	203.7 ± 151.1
	Noncitrus fruits	35.4	169.3 ± 144.8	Noncitrus fruits	60.0**	191.8 ± 162.3
	Other dark green vegetables	26.0	64.4 ± 65.1	Other dark green vegetables	32.5*	69.6 ± 70.8
	Tomatoes/juice/sauce	7.47	397.4 ± 364.4	Fruit drinks/juice drinks	35.4**	299.8 ± 230.1
	Fruit drinks/juice drinks	22.1	315.2 ± 256.8	Noncitrus fruit juice	32.5*	69.6 ± 70.8
	Noncitrus fruit juice	26.0	64.4 ± 65.1	Tomatoes/juice/sauce	9.08	348.8 ± 311.9
	Potatoes boiled/mashed	29.2	198.1 ± 149.6	Dark yellow/orange vegetables	39.5	89.0 ± 90.7

[1] Values are mean ± SD. Significantly different from smokers *** $P < 0.001$ ** $P < 0.01$ * $P = 0.05$ (χ^2 analysis or Student's t test). Please note: For some foods, * appear in the smokers' category. This is because the food did not appear in first 8 foods in the non-smokers group but statistical testing was done.

[2] Freq (%) refers to the number of subjects consuming the particular food on the day of recall.

[3] Amount (g/d) refers to the mean intake among consumers of that food.

etables on the day of the recall and they were more likely to consume carbonated beverages, coffee and tea.

The average number of servings of vegetables and fruit fell below the minimum suggested number of 5 servings/d for people of both sexes who smoke (**Table 4**). Only 30% of people who smoke compared with 48% of people who do not smoke ($\chi^2 < 0.001$) met the minimum suggested number of portions for fruits and vegetables.

Variability in eating pattern. Day-to-day variability in nutrient intake was compared to evaluate whether people who smoke had more variable intakes of nutrients. Intra/intersubject ratios were generally >1 for all nutrients examined (**Table**

TABLE 4

Average number of servings of food groups from Canada's Food Guide to Healthy Eating among men and women stratified by smoking status[1,2]

	Men (n = 571)		Women (n = 970)	
Food groups	Smokers (n = 127)	Nonsmokers (n = 444)	Smokers (n = 181)	Nonsmokers (n = 789)
Grain products	6.2 ± 4.0	7.2 ± 4.6*	4.1 ± 2.7	5.1 ± 2.9*
Vegetables and fruit	4.0 ± 3.7	5.6 ± 4.1*	3.7 ± 3.6	4.8 ± 3.5*
Milk products	1.8 ± 1.8	1.8 ± 1.9	1.3 ± 1.3	1.5 ± 2.1
Meat and alternatives	3.4 ± 2.9	3.4 ± 2.7	2.1 ± 2.1	2.0 ± 1.8

[1] Values are means ± SD.
[2] $P \leq 0.05$ (comparison of smokers vs. nonsmokers stratified by sex, ANOVA with Scheffé's test).

5). There were no distinct patterns in variability by smoking status.

Comparison of nutrient intake with Dietary Reference Intake. To examine whether people who smoke met the recommended levels of intake despite lower intakes of some nutrients, we analyzed the percentage of men and women meeting the Dietary Reference Intake for calcium (AI), folate, vitamin C, iron and zinc (EAR) by smoking status (**Table 6**) (25,31–33). A greater percentage of people who smoke failed to meet the EAR for smokers for vitamin C ($\chi^2 < 0.001$). Most men met the EAR for iron, irrespective of smoking status (98 vs. 99.5%), whereas for women, a smaller percentage of those who smoked met the EAR for iron (87% of those who smoke vs. 93% of those who do not smoke, $\chi^2 < 0.01$). Most people in both smoking categories met the EAR for zinc. Most women, irrespective of smoking status, had mean intakes below the EAR for folate. Stratification by education level did not modify these relationships.

Supplement use. Overall, 38.5% of subjects reported using dietary supplements. People who smoked were less likely to take dietary supplements (21.3 vs. 29.7% among men, $\chi^2 < 0.001$ and 37 vs. 43.5% among women, $\chi^2 < 0.001$). Women who reported not smoking were more likely to take calcium supplements than women who reported smoking (18 vs. 10%, $\chi^2 < 0.05$).

TABLE 5

Ratio of intra- and intersubject variability among men and women stratified by smoking status

	Men (n = 571)		Women (n = 970)	
Nutrient	Smokers (n = 127)	Nonsmokers (n = 444)	Smokers (n = 181)	Nonsmokers (n = 789)
Energy	1.19	1.05	1.06	1.69
Calcium	0.98	0.96	0.98	1.19
Iron	2.93	1.27	1.35	1.59
Zinc	1.62	1.99	0.84	1.84
Folate	0.82	1.47	1.13	1.41
Vitamin C	0.69	1.43	0.86	1.34

TABLE 6

Percentage of men and women stratified by smoking status meeting recommendations for calcium, iron, zinc, folate and vitamin C[1]

	Men (n = 571)		Women (n = 970)	
Nutrient	Smokers (n = 127)	Nonsmokers (n = 444)	Smokers (n = 181)	Nonsmokers (n = 789)
	%			
Calcium, *mg*	33.1	33.0	17.1	15.8
Iron, *mg*	98.4	99.6	87.3	93.4**
Zinc, *mg*	75.6	77.3	70.7	77.5
Folate, *μg*	25.2	35.6*	8.3	12.8
Vitamin C, *mg*	36.2	72.7***	39.2	77.2***

[1] Adjusted for within subject variability before calculating the prevalence of adequate intakes. Significantly different from smokers: *** $P < 0.001$ ** $p < 0.01$ * $P < 0.05$ (χ^2 analysis).

DISCUSSION

Our results suggest important dietary differences between those who smoke and those who do not. Those who smoke had relatively higher intakes of fat and saturated fat, and lower intakes of folate, vitamin C and fiber. Food choices by smoking group support the observed nutrient differences.

Several studies have reported that antioxidants such as ascorbic acid may attenuate adverse health effects associated with cigarette smoking by scavenging the free radicals produced by tobacco smoke (2,13). However, the intake of antioxidants by smokers is low, placing them at higher risk of oxidative stress (9,35,36). High intake of saturated fat raises total cholesterol and LDL cholesterol levels and is a risk factor for coronary heart disease (37). People who smoke tend to have high intakes of saturated fat and also to have increased levels of VLDL cholesterol and low HDL cholesterol levels (38). In addition, low folate intake is a risk factor for coronary heart disease and certain forms of cancer (39). On the basis of our results, we find that people who smoke have slightly higher intakes of total fat and saturated fat (9%) and lower intakes of folate (14%), vitamin C (24%) and fiber (23%). This is consistent with those reported in other populations (3,6). Although the differences may appear small, such dietary differences are predicted to be associated with higher levels of cardiovascular disease risk and decreased life expectancy (40). Consequently, in addition to the toxic effects of smoke, those who smoke are at increased risk of developing chronic diseases related to diet.

Although fruits and vegetables were among the most important contributors to folate and vitamin C, a smaller proportion of smokers consumed these foods, leading to lower mean intakes of these two vitamins. This effect was consistent among several food groupings of fruits and vegetables, which is consistent with other studies (3,41,42). The average number of servings of fruits and vegetables was below the minimum recommended 5 servings/d for people of both sexes who smoked. Possible reasons for lower consumption of fruits and vegetables include changes in taste acuity induced by smoking that could influence food choices (2). Finally, several studies suggest that those who smoke and those who do not have different health priorities and habits (43–45).

People who do not smoke were more likely to use supplements, particularly nonsmoking women who were more likely

to take calcium supplements than women who smoke supporting other studies indicating a healthier lifestyle among those who do not smoke (46,47) .

Diet may be a confounder when studying the relationship between smoking and chronic disease. Those who smoke have been reported to have higher intakes of saturated fat and in addition, to have unfavorable lipid and lipoprotein levels (38) so that the effects of smoking and diet are acting in the same direction. Therefore, failure to control for the confounding effect of diet when examining the relationship between smoking and chronic diseases may result in overestimation of relative risk.

Two methodological issues not addressed in earlier studies on diet and smoking status include EI:BMR_{est} and intra- and intersubject variability that were examined in this study. In our study, the mean EI/BMR_{est} values for men and women were similar to those reported in NHANES III and other studies (48,49). Although men appear to report adequate intakes, the mean EI/BMR_{est} among women was ~1.25, below the cut-off value of 1.35, indicating underreporting (50). The lower EI/BMR_{est} values for women appear to be a problem in surveys (51). The similar EI/BMR_{est} values among those who smoke and do not smoke provide evidence that underreporting was similar in the two smoking groups.

People who smoke did not report higher variability in nutrient intakes. The lack of difference in day-to-day variation indicates that the diet of those who smoke is no more variable than that of those who do not smoke.

Previous studies reporting on differences in BMI by smoking group have found differing results, with some reporting lower BMI among smokers and others, including our results, not showing any differences in BMI (9,52–56). There is similar disagreement in the literature concerning whether energy intakes are higher among smokers or not (6,10,53).

The extent to which we can generalize these results to the Canadian population is limited by the low response rate achieved. Response rates to health surveys appear to be dropping (57,58). The sample, however, appeared to be representative of the sociodemographic profile of Canadians.

In conclusion, those who smoke consumed a less healthy diet than those who do not smoke. The finding that nutrient and food group intake varied by smoking status has public health implications because the less healthy dietary patterns of those who smoke place them at an even greater risk for developing chronic disease than those who do not smoke. Studies examining smoking disease relationships should control for the confounding effect of diet, given these consistent findings for nutrient intakes from both food and supplement sources.

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