The Journal of Nutrition
Community and International Nutrition

Food Insecurity Is Associated with Nutrient Inadequacies among Canadian Adults and Adolescents[1–3]

Sharon I. Kirkpatrick* and Valerie Tarasuk

Department of Nutritional Sciences, Faculty of Medicine, University of Toronto, Toronto, ON M5S 3E2

Abstract

Household food insecurity constrains food selection, but whether the dietary compromises associated with this problem heighten the risk of nutrient inadequacies is unclear. The objectives of this study were to examine the relationship between household food security status and adults' and children's dietary intakes and to estimate the prevalence of nutrient inadequacies among adults and children, differentiating by household food security status. We analyzed 24-h recall and household food security data for persons aged 1–70 y from the 2004 Canadian Community Health Survey (cycle 2.2). The relationship between adults' and children's nutrient and food intakes and household food security status was assessed using regression analysis. Estimates of the prevalence of inadequate nutrient intakes by food security status and age/sex group were calculated using probability assessment methods. Poorer dietary intakes were observed among adolescents and adults in food-insecure households and many of the differences by food security status persisted after accounting for potential confounders in multivariate analyses. Higher estimated prevalences of nutrient inadequacy were apparent among adolescents and adults in food-insecure households, with the differences most marked for protein, vitamin A, thiamin, riboflavin, vitamin B-6, folate, vitamin B-12, magnesium, phosphorus, and zinc. Among children, few differences in dietary intakes by household food security status were apparent and there was little indication of nutrient inadequacy. This study indicates that for adults and, to some degree, adolescents, food insecurity is associated with inadequate nutrient intakes. These findings highlight the need for concerted public policy responses to ameliorate household food insecurity. J. Nutr. 138: 604–612, 2008.

Introduction

Findings from cycle 2.2 of the Canadian Community Health Survey (CCHS 2.2)[4] indicate that 9.2% of Canadian households experienced food insecurity in 2004 (1). Food insecurity [as assessed by the Household Food Security Survey Module (HFSSM)] was more prevalent among households with lower income adequacy, those reliant on social assistance, and those headed by a female lone parent (1), consistent with analyses of earlier population surveys (2–5). Although the sociodemographic correlates of household food insecurity in Canada have been documented, the nutrition implications of this problem are not well understood. Small, regional Canadian studies indicate limited food selection (6,7) and suboptimal nutrient intakes (8–10) among adults in relation to indicators of food insecurity. The general direction of these findings is consistent with results from U.S. population surveys showing lower energy and nutrient intakes among adults in households characterized by food insufficiency (11–13) and food insecurity (14) compared with those in more food-secure settings. Although some U.S. studies have also documented lower energy and nutrient intakes among preschoolers in food-insufficient households, food insecurity appears to have a lesser impact on children's dietary intakes compared with adults (11,12).

Although the existing literature indicates that household food insecurity affects food selection and dietary intakes, it is not well understood whether the dietary compromises are of sufficient magnitude to impact nutritional status. In both Canada and the U.S., there have been some attempts to assess observed nutrient intake levels in relation to requirement estimates through comparisons of group mean intake estimates to recommended dietary allowances (9,14) or calculations of the proportion of intakes below some percentage of the recommended dietary allowances (12,13,15). Neither approach constitutes a valid comparison of observed intakes to nutrient requirement distributions (16). A few Canadian studies have documented high levels of nutrient inadequacy among adults in relation to indicators of food

---

[1] Supported by an Ontario Graduate Scholarship and a Social Sciences and Humanities Research Council Canada Graduate Scholarship to S.I.K.

[2] Author disclosures: S. Kirkpatrick and V. Tarasuk, no conflicts of interest.

[3] Supplemental Tables 1–7 are available with the online posting of this paper at jn.nutrition.org.

[4] Abbreviations used: CCHS, Canadian Community Health Survey; EAR, estimated average requirement; EER, estimated energy requirement; EI, energy intake; HFSSM, Household Food Security Survey Module.

* To whom correspondence should be addressed. E-mail: sharon.kirkpatrick@utoronto.ca.

Manuscript received 25 October 2007. Initial review completed 1 December 2007. Revision accepted 27 December 2007.

insecurity utilizing probability assessment methods (17,18). However, this research is limited by the absence of food-secure comparison groups and provides little insight into whether household food insecurity heightens individuals' risk of nutrient inadequacies. A recent U.S. study found higher prevalences of inadequacy for a number of nutrients among adults in households characterized by food insufficiency (19). This study was hampered by the small number of food-insufficient individuals but suggests that nutritional health may be compromised in the context of household food insufficiency.

This study draws upon data from CCHS 2.2 to examine the nutritional implications of household food insecurity for Canadian adults and children. The objectives of this study were to: *1*) examine the relationship between household food security status and children's and adult's intakes of energy, macronutrients, micronutrients, and number of servings consumed of foods groups from Canada's Food Guide; and 2) estimate the prevalence of nutrient inadequacy among adults and children, differentiating by household food security status and age/sex group.

Materials and Methods

Approval for this study was obtained from the University of Toronto Research Ethics Board.

Data. This analysis utilized data from cycle 2.2 of the CCHS, conducted by Statistics Canada between January 2004 and January 2005 (20). The survey sample consisted of 35,107 respondents of all ages living in private residences in Canada's 10 provinces (20). Initial interviews, consisting of a demographic and general health questionnaire, a 24-h dietary intake recall, and the 18-item HFSSM, were conducted by in-person interviews. A second 24-h recall was conducted by telephone with 10,786 respondents 3 to 10 d after the initial interview (20). Parents or guardians provided responses to the HFSSM for respondents <18 y old, provided 24-h recall data for children ≤5 y old, and assisted with the provision of 24-h recall data for children between the ages of 6 and 11 y (20).

Data for children aged 1–18 y (excluding those whose only source of nutrients was breast milk), males, and nonpregnant, nonlactating females aged 19–70 y were analyzed. Adults aged >70 y ($n = 4382$) were excluded due to the small number of second 24-h recalls available. Missing food security data resulted in the exclusion of 71 respondents. Imputation of responses to the HFSSM, following the methods outlined in the Guide to Measuring Household Food Security (21), was conducted for 64 respondents with partial food security data.

Household food security. The household food security status of survey respondents over the past 12 mo was classified using the coding method adopted by Health Canada (1), deriving a household variable based on responses to the HFSSM's 10 adult-referenced and 8 child-referenced items. For both adults and children, food insecurity was indicated by 2 or more affirmative responses to the respective items. A dichotomous household food security variable was then constructed, characterizing respondents of households within which either or both adults and/or children were affected by food insecurity as food insecure and those in households within which neither adults nor children were affected as food secure (1).

Although it has been suggested that only the adult-referenced items be used to describe the household food security status of adults from samples that are composed of persons from both households with and without children (22), preliminary analysis indicated that 98.5% of adults in food-insecure households based on the household measure would also be classified as food-insecure based on the food security status of only adults in the household. Because food security typically affects adults before children (23,24), the classification of some children does differ depending on whether or not the food security status of adults in the household is considered; 47.4% of children considered to be in food-insecure households based on the household measure would be classified as food secure if only the child-referenced items were considered. However, repeating the analyses of children's data (described below) using a measure of food security derived from the child-referenced items resulted in only small shifts in our findings, with the overall impression remaining unchanged. Thus, results based on the household measure are presented with the exception of those noted in the "Results" section and included in the Online Supporting Material for comparison purposes.

Dietary intakes. Energy and nutrient intakes from food as well as servings consumed from the 4 food groups in Canada's Food Guide to Healthy Eating (i.e. milk products, fruit and vegetables, meat and alternatives, and grain products) (25) were calculated for each recall day (20). Energy density was derived by dividing energy in kilojoules consumed by each individual by the number of grams of food consumed, excluding nonnutritive beverages (26). Preliminary examination of the distributions of nutrient intakes from the 24-h recall data indicated extreme outliers for some nutrients that affected our ability to normalize the data. The raw nutrient values were log transformed and extreme values were identified as those exceeding the 75th percentile plus 3 multiples of the interquartile range of the log-transformed distribution (27). Respondents identified as having 1 or more extreme value in their recall data and those that were missing data for all nutrients examined ($n = 268$) were excluded. The number of respondents in the analytic dataset ($n = 29,883$) by age/sex group and household food security status is outlined in **Table 1**.

To explore the quality of food intake reporting, energy intake (EI) was examined in relation to estimated energy requirements (EER) (19,28,29) using equations based on respondents' sex, age, self-reported activity level, height, and weight to estimate requirements (30). Although this parameter is termed EER for normal weight individuals and total energy expenditure for overweight or obese individuals (30), the principles of estimation are similar and we therefore refer to both as EER. Only data from respondents for whom measured height and weight were available (60% of the sample) were included in these calculations. EER was not calculated for children in the 1–3 y age group, because anthropometric measurements were unavailable for those <2 y. The EER physical activity coefficients pertain to both activities of daily living and leisure time activities and take intensity of activity into account (30). The data available in CCHS 2.2 pertain only to leisure time activities and low intensity was assumed by Statistics Canada because respondents were not asked to report on intensity (20). Based on data on the frequency and duration of activity, Statistics Canada categorized respondents aged ≥12 y as active, moderate, or inactive (20). The EER physical activity coefficients for active, low active, and sedentary (30) were applied respectively according to the respondent's age and gender. Because data on activity level were not available for respondents <12 y old, the sedentary category was assumed for these respondents.

TABLE 1 Sample size and number of 2nd 24-h dietary recalls by age/sex subgroup and household food security status

	Food secure		Food insecure	
Age/sex subgroup	Respondents	2nd recalls	Respondents	2nd recalls
			n	
Both, 1–3 y	891	275	114	37
Both, 4–8 y	1749	395	199	49
Males, 9–13 y	966	347	154	66
Females, 9–13 y	961	313	103	36
Males, 14–18 y	1051	313	89	23
Females, 14–18 y	989	274	86	34
Males, 19–30 y	2464	726	333	119
Females, 19–30 y	2112	785	336	88
Males, 31–50 y	4874	1151	395	119
Females, 31–50 y	4570	987	488	127
Males, 51–70 y	3206	749	178	43
Females, 51–70 y	3272	777	253	70

Covariates. Additional variables were derived to enable an examination of whether differences observed in dietary intakes in relation to household food security status were independent of other factors that influence dietary intakes. A 5-level variable constructed by Statistics Canada describes income adequacy according to total household income in the past 12 mo and the number of people in the household. The highest level of education obtained by the respondent in the case of adults and by any member of the household in the case of children was classified as less than secondary school graduation, secondary school graduation, some postsecondary education, and postsecondary graduation. Data on immigration status were used to classify respondents as nonimmigrants, immigrated <10 y ago, or immigrated ≥10 y ago. To account for household size, continuous variables were derived to indicate the number of adults and number of children aged 0–5 y, 6–11 y, and 12–18 y in each household. Among adults, a dichotomous variable was derived to differentiate those who were current daily smokers from those who were not.

Statistics. Statistical analyses were performed using SAS (version 9.1, 2003, SAS Institute) and SIDE-IML (version 1.11, 2001, Iowa State University). All estimates are weighted to be nationally representative (20). SD for means and regression coefficients as well as *P*-values derived from regression analyses were calculated using the bootstrap resampling technique to account for the complex sampling design of CCHS 2.2. Differences were considered significant at $P < 0.05$. To satisfy the ANOVA requirement of a normally distributed dependent variable, the values of the dependent variables for ANOVA models were transformed to approximate the normal distribution using the Box-Cox method (31).

We first examined whether dietary intakes from food, as measured by the first 24-h recall, differed among adults and children in relation to their household food security status. We used ANOVA to investigate whether household food security status was associated with quantitative differences in intakes of energy (in kilojoules and in relation to EER), macronutrients (including protein expressed both in grams and in g/kg), vitamins, and minerals. This analysis was conducted within the age/sex groups for which requirement estimates are defined (30,32–36), including only those with measured height and weight data in the analysis of protein (g/kg) and EI:EER. We also used ANOVA to examine whether household food security status was associated with qualitative differences in diet, as indicated by energy density; proportion of energy from carbohydrates, protein, and fat; and food group servings. To examine whether household food security status was independently associated with intakes, each ANOVA model was repeated using the covariates described above, including the smoking variable for the adult age/sex subgroups.

We then examined the nutritional adequacy of intakes by age/sex group and household food security status using data from the first 24-h recall and the 2nd recall available for a subsample of respondents (Table 1). We used SIDE-IML software to estimate the distributions of usual nutrient intakes, using data from the 2nd 24-h recall to adjust for day-to-day variation in intakes (16). The prevalence of inadequate intakes was then estimated using the estimated average requirement (EAR) cut-point approach (16) for nutrients for which an EAR has been set (30,32–36), differentiating by age/sex group and household food security status. The standard error estimates generated by SIDE-IML were used to calculate 95% CI. Recognizing that the EAR cut-point approach is not well suited for the estimation of prevalences of inadequacy at the tails of the distribution (16), we report only prevalence estimates of 10% or higher.

Significant associations between household food security status and daily smoking were observed among adults in food-insecure households (Table 1). To account for the increased requirement for vitamin C associated with smoking (34), the EAR for each adult age/sex and food security subgroup was weighted according to the proportion of respondents in the respective subgroup that reported daily smoking.

TABLE 2 Distribution of adult respondents by sociodemographic covariates

	Males			Females		
Characteristic	Food secure	Food insecure	*P*-value[1]	Food secure	Food insecure	*P*-value[1]
	n (%)			*n (%)*		
n	10544	906		9954	1076	
Income adequacy						
Lowest	171 (1.6)	124 (13.7)	<0.01	178 (1.8)	174 (16.1)	<0.01
Lower middle	276 (2.6)	186 (20.6)		374 (3.8)	230 (21.4)	
Middle	1521 (14.4)	232 (25.6)		1650 (16.6)	398 (37.0)	
Upper middle	3624 (34.4)	265 (29.2)		3364 (33.8)	158 (14.7)	
Upper	4085 (38.7)	51 (5.7)		3470 (34.9)	55 (5.1)	
Not stated	867 (8.2)	47 (5.2)		919 (9.2)	61 (5.6)	
Education						
Less than secondary school graduation	1603 (15.2)	224 (24.7)	<0.01	1444 (14.5)	255 (23.7)	<0.01
Secondary school graduation	1705 (16.2)	230 (25.4)		1922 (19.3)	217 (20.1)	
Some postsecondary education	1042 (9.9)	89 (9.8)		952 (9.6)	100 (9.3)	
Postsecondary graduation	6114 (58.0)	350 (38.6)		5517 (55.4)	490 (45.5)	
Not stated	81 (0.8)	14 (1.5)		120 (1.2)	14 (1.3)	
Immigrant status						
Born in Canada	8069 (76.5)	638 (70.4)	0.08	7721 (77.6)	844 (78.5)	0.02
Immigrated to Canada <10 y ago	795 (7.5)	131 (14.4)		694 (7.0)	136 (12.6)	
Immigrated to Canada ≥10 y ago	1663 (15.8)	135 (14.9)		1532 (15.4)	95 (8.9)	
Smoking						
Current daily smoker	2554 (24.1)	374 (41.3)	<0.01	1743 (17.5)	407 (37.9)	<0.01
Not a current daily smoker	7998 (75.9)	532 (58.7)		8204 (82.5)	669 (62.1)	
Household size, *n*	*Mean ± SD*			*Mean ± SD*		
Adults	2.36 ± 0.02	2.38 ± 0.10	0.01	2.26 ± 0.03	1.94 ± 0.07	<0.01
Children aged 0–4 y	0.20 ± 0.01	0.26 ± 0.05	0.32	0.17 ± 0.02	0.33 ± 0.05	<0.01
Children aged 5–11 y	0.22 ± 0.01	0.19 ± 0.05	0.12	0.24 ± 0.02	0.26 ± 0.04	0.68
Children aged 12–18 y	0.28 ± 0.02	0.25 ± 0.07	0.18	0.25 ± 0.01	0.27 ± 0.04	0.53

[1] *P*-values were derived from chi-square tests for categorical variables and ANOVA for continuous variables, stratified by sex and household food security status.

We applied the probability method to estimate the prevalence of inadequacy for iron to account for the skewed nature of the requirement distributions for this nutrient (16). The distributions of requirements used for females aged 9–13 y, 14–18 y, 19–30 y, and 31–50 y were weighted to account for the decreased iron requirements associated with the use of oral contraceptive agents (reported by 21.2% of females aged 15–50 y) and nonmenstruation (reported by 17.7% of females aged 9–50 y) (35).

Results

The characteristics of the sample in relation to household food security status are outlined for adults (**Table 2**) and children (**Supplemental Table 1**).

Adults. Among males aged 31–50 y and both males and females aged 51–70 y, reported EI were lower among those in food-insecure households (**Table 3**). Mean EI:EER was below 1 for all adult subgroups, but the only significant associations with household food security status observed were the lower ratios among females in the 19–30 y and 51–70 y age groups in food-insecure households (Table 3). Household food insecurity was negatively associated with intakes of protein (both in grams and g/kg), fat, and fiber among several adult age/sex subgroups (Table 3) and negative associations were observed between household food insecurity and intakes of all vitamins and minerals examined, at least for some subgroups (**Table 4**). Higher energy density was associated with household food insecurity for females in the 19–30 y and 31–50 y age groups (**Table 5**). Food insecurity was associated with a higher proportion of energy obtained from carbohydrates for most subgroups (Table 5) and was negatively associated with consumption of fruits and vegetables (with the exception of males aged 31–50 y) and milk products (**Table 6**). Fewer servings of meats and alternatives were consumed by males 31–50 y and males and females 51–70 y in food-insecure households and food insecurity was negatively associated with the consumption of grain products among females aged 19–30 y. The inclusion of covariates in the ANOVA models resulted in the attenuation of some of the effects of household food security status on intakes (Tables 3–6). However, many differences in intakes in relation to household food security status persisted (Tables 3–6).

Among adults in food-insecure households, the prevalence of inadequacy ranged from 42 to 76% for magnesium and 47 to 69% for vitamin A depending on the age/sex group considered, but high levels of inadequacy were also noted in most age/sex groups for protein and zinc, with prevalence estimates considerably higher for those in food-insecure than food-secure households in most cases (**Table 7**). Similar patterns were observed for vitamin B-6, folate, and vitamin B-12 in selected groups. No age/sex group had a prevalence of niacin inadequacy in excess of 10% irrespective of food security status and only those in food-insecure households in some age/sex groups exhibited prevalences of inadequacy above 10% for thiamin, riboflavin, and phosphorus (Table 7). The prevalence of iron inadequacy exceeded 10% only for females 19–30 y and 31–50 y, but higher prevalences were observed for food-insecure groups in both cases (Table 7).

Children. Among children, no differences by household food security status were observed in EI or EI:EER in the unadjusted

TABLE 3 Adults' mean energy and macronutrient intakes from first 24-h recall in relation to household food security status[1,2]

	Males 19–30 y		Females 19–30 y		Males 31–50 y		Females 31–50 y		Males 51–70 y		Females 51–70 y	
	Intake	*P*-value (adjusted)[3]	Intake	*P*-value (adjusted)[3]	Intake	*P*-value (adjusted)[3]	Intake	*P*-value (adjusted)[3]	Intake	*P*-value (adjusted)[3]	Intake	*P*-value (adjusted)[3]
Energy, *kJ*												
Food secure	11434 ± 212	0.62	8030 ± 159	0.08	10544 ± 176	0.03	7742 ± 130	0.06	9213 ± 132	0.03	7111 ± 92	<0.01
Food insecure	11123 ± 431	(0.66)	7381 ± 281	(0.37)	9436 ± 686	(0.29)	7141 ± 274	(0.12)	8176 ± 452	(0.06)	6177 ± 296	(0.11)
Energy,[4] *EI:EER*												
Food secure	0.79 ± 0.02	0.42	0.79 ± 0.02	0.01	0.81 ± 0.02	0.20	0.78 ± 0.02	0.51	0.77 ± 0.01	0.54	0.80 ± 0.01	<0.01
Food insecure	0.69 ± 0.03	(0.31)	0.69 ± 0.03	(0.02)	0.70 ± 0.05	(0.15)	0.76 ± 0.04	(0.73)	0.70 ± 0.04	(0.46)	0.70 ± 0.04	(0.20)
Protein, *g*												
Food secure	107.3 ± 2.5	0.17	74.1 ± 1.9	<0.01	105.8 ± 2.2	<0.01	76.4 ± 1.6	<0.01	93.0 ± 1.6	<0.01	73.1 ± 1.2	<0.01
Food insecure	99.3 ± 4.4	(0.40)	63.8 ± 2.66	(0.16)	83.0 ± 6.2	(<0.01)	67.4 ± 3.0	(0.14)	77.0 ± 4.2	(0.02)	56.0 ± 4.0	(0.08)
Protein,[4] *g/kg*												
Food secure	1.39 ± 0.04	0.65	1.18 ± 0.03	<0.01	1.29 ± 0.03	<0.01	1.15 ± 0.03	0.13	1.13 ± 0.02	0.71	1.09 ± 0.02	<0.01
Food insecure	1.32 ± 0.07	(0.74)	0.95 ± 0.04	(<0.01)	1.02 ± 0.06	(<0.01)	0.99 ± 0.05	(0.63)	0.97 ± 0.06	(0.60)	0.87 ± 0.07	(0.09)
Carbohydrates, *g*												
Food secure	338.6 ± 6.7	0.57	248.9 ± 5.0	0.10	299.7 ± 5.6	0.70	224.2 ± 3.9	0.81	257.3 ± 3.6	0.53	211.2 ± 3.0	0.04
Food insecure	328.1 ± 18.4	(0.73)	229.1 ± 9.6	(0.37)	298.3 ± 22.5	(0.73)	221.0 ± 10.4	(0.47)	248.4 ± 12.8	(0.36)	193.6 ± 8.8	(0.16)
Fiber, *g*												
Food secure	19.3 ± 0.5	0.58	14.9 ± 0.4	<0.01	19.2 ± 0.4	0.13	15.8 ± 0.4	<0.01	19.0 ± 0.4	<0.01	16.6 ± 0.3	0.01
Food insecure	18.9 ± 1.4	(0.85)	12.0 ± 0.5	(0.03)	17.7 ± 1.5	(0.77)	13.0 ± 0.7	(0.01)	15.6 ± 1.3	(0.12)	14.6 ± 1.0	(0.28)
Fat, *g*												
Food secure	97.8 ± 2.3	0.24	67.5 ± 1.9	0.33	92.8 ± 2.1	<0.01	69.5 ± 1.6	0.03	82.0 ± 1.8	0.05	62.1 ± 1.1	<0.01
Food insecure	90.8 ± 4.4	(0.13)	63.4 ± 3.0	(0.64)	76.2 ± 6.7	(0.07)	61.2 ± 3.9	(0.07)	69.1 ± 5.9	(0.21)	52.9 ± 3.4	(0.15)

[1] Values are means ± SD.

[2] Refer to Table 1 for *n* for each age/sex and food security subgroup.

[3] *P*-values were derived from ANOVA stratified by age/sex group and with Box-Cox transformed nutrient intakes as the dependent variables and dichotomous household food security status as the independent variable. Adjusted *P*-values were derived from multivariate ANOVA with income adequacy, respondent education, immigrant status, current daily smoking status, and household size variables included as covariates.

[4] Energy requirements and protein intakes in g/kg were estimated for respondents for whom measured anthropometric data were available.

TABLE 4 Adults' mean micronutrient intakes from first 24-h recall in relation to household food security status[1,2]

	Males 19–30 y		Females 19–30 y		Males 31–50 y		Females 31–50 y		Males 51–70 y		Females 51–70 y	
	Intake	*P*-value (adjusted)[3]	Intake	*P*-value (adjusted)[3]	Intake	*P*-value (adjusted)[3]	Intake	*P*-value (adjusted)[3]	Intake	*P*-value (adjusted)[3]	Intake	*P*-value (adjusted)[3]
Vitamin A, *RAE*												
Food secure	695.0 ± 25.0	0.03	603.4 ± 26.0	<0.01	713.4 ± 28.2	0.27	641.3 ± 19.7	0.10	762.8 ± 24.9	<0.01	652.5 ± 18.3	0.03
Food insecure	597.3 ± 60.0	(0.07)	478.3 ± 47.7	(0.08)	703.3 ± 84.3	(0.93)	575.3 ± 57.6	(0.44)	579.5 ± 77.7	(0.03)	558.8 ± 56.2	(0.50)
Vitamin D, *μg*												
Food secure	5.9 ± 0.3	0.34	4.7 ± 0.2	0.19	5.7 ± 0.2	0.25	5.2 ± 0.3	0.09	7.2 ± 0.5	<0.01	5.1 ± 0.3	0.07
Food insecure	5.4 ± 0.4	(0.35)	4.2 ± 0.4	(0.96)	6.4 ± 1.6	(0.80)	4.4 ± 0.4	(0.24)	4.9 ± 0.7	(<0.01)	4.0 ± 0.3	(0.21)
Vitamin C, *mg*												
Food secure	162.3 ± 7.5	<0.01	135.5 ± 5.4	<0.01	128.5 ± 4.0	0.31	117.2 ± 3.8	0.06	130.6 ± 4.8	0.26	122.4 ± 3.1	0.01
Food insecure	119.0 ± 14.5	(<0.01)	109.3 ± 10.8	(0.08)	122.9 ± 17.1	(0.83)	109.3 ± 11.6	(0.17)	115.6 ± 18.0	(0.59)	101.5 ± 10.1	(0.53)
Thiamin, *mg*												
Food secure	2.2 ± 0.1	0.05[2]	1.5 ± 0.04	0.01	2.0 ± 0.05	0.03	1.5 ± 0.03	0.05[2]	1.9 ± 0.03	0.01	1.5 ± 0.03	0.01
Food insecure	1.9 ± 0.1	(0.14)	1.3 ± 0.07	(0.28)	1.8 ± 0.2	(0.29)	1.4 ± 0.1	(0.20)	1.6 ± 0.1	(0.01)	1.3 ± 0.1	(0.19)
Riboflavin, *mg*												
Food secure	2.4 ± 0.1	0.13	1.7 ± 0.04	0.02	2.2 ± 0.05	<0.01	1.7 ± 0.03	0.03	2.0 ± 0.03	<0.01	1.6 ± 0.02	<0.01
Food insecure	2.2 ± 0.1	(0.15)	1.5 ± 0.07	(0.25)	2.0 ± 0.1	(0.11)	1.6 ± 0.07	(0.18)	1.7 ± 0.1	(<0.01)	1.4 ± 0.09	(0.09)
Niacin, *mg*												
Food secure	49.8 ± 1.1	0.46	33.7 ± 0.8	<0.01	48.6 ± 0.9	<0.01	35.9 ± 0.8	<0.01	44.0 ± 0.7	0.01	33.9 ± 0.6	<0.01
Food insecure	47.2 ± 2.2	(0.59)	29.5 ± 1.2	(0.18)	41.2 ± 3.6	(0.05)	31.8 ± 1.3	(0.17)	38.1 ± 2.1	(0.10)	29.0 ± 2.1	(0.21)
Vitamin B, *mg*												
Food secure	2.3 ± 0.1	0.16	1.6 ± 0.04	<0.01	2.2 ± 0.05	<0.01	1.6 ± 0.03	<0.01	2.1 ± 0.04	<0.01	1.7 ± 0.03	0.08
Food insecure	2.1 ± 0.1	(0.53)	1.4 ± 0.1	(0.10)	1.9 ± 0.2	(0.14)	1.4 ± 0.1	(0.09)	1.6 ± 0.1	(<0.01)	1.5 ± 0.1	(0.88)
Folate, *μg*												
Food secure	590.2 ± 15.1	0.15	421.6 ± 11.1	0.04	527.8 ± 11.4	0.37	424.4 ± 9.9	0.03	483.3 ± 7.9	0.12	402.2 ± 6.5	<0.01
Food insecure	537.8 ± 28.8	(0.33)	370.1 ± 20.2	(0.35)	508.9 ± 31.6	(0.75)	377.7 ± 19.2	(0.06)	441.1 ± 34.4	(0.13)	321.9 ± 24.0	(<0.01)
Vitamin B-12, *μg*												
Food secure	5.3 ± 0.3	0.02	3.4 ± 0.2	<0.01	5.3 ± 0.3	<0.01	3.5 ± 0.1	0.09	4.8 ± 0.2	<0.01	3.7 ± 0.1	<0.01
Food insecure	4.1 ± 0.3	(0.02)	2.7 ± 0.2	(0.23)	3.9 ± 0.4	(<0.01)	3.1 ± 0.2	(0.33)	3.2 ± 0.4	(<0.01)	2.8 ± 0.3	(0.09)
Calcium, *mg*												
Food secure	1120.1 ± 36.4	0.03	881.0 ± 28.7	0.02	945.6 ± 21.3	<0.01	832.1 ± 19.3	0.05	836.3 ± 16.9	0.01	755.0 ± 13.9	0.02
Food insecure	951.7 ± 74.6	(0.07)	751.8 ± 48.6	(0.33)	778.9 ± 65.9	(0.22)	749.6 ± 52.3	(0.21)	676.8 ± 65.0	(<0.01)	658.6 ± 57.1	(0.14)
Iron, *mg*												
Food secure	17.5 ± 0.4	0.53	12.7 ± 0.3	<0.01	16.6 ± 0.3	0.02	12.4 ± 0.2	0.03	15.1 ± 0.2	<0.01	12.4 ± 0.2	0.03
Food insecure	16.8 ± 0.8	(0.98)	10.7 ± 0.4	(0.20)	15.0 ± 1.5	(0.27)	11.2 ± 0.5	(0.11)	12.5 ± 0.7	(<0.01)	11.1 ± 0.9	(0.18)
Magnesium, *mg*												
Food secure	379.7 ± 8.2	0.28	288.7 ± 6.3	<0.01	374.8 ± 6.3	<0.01	307.3 ± 4.6	<0.01	354.4 ± 4.9	<0.01	301.4 ± 4.6	0.06
Food insecure	357.6 ± 17.6	(0.64)	251.9 ± 10.1	(0.29)	335.5 ± 26.8	(0.26)	265.0 ± 11.0	(0.02)	292.6 ± 18.9	(0.02)	275.1 ± 19.6	(0.89)
Phosphorous, *mg*												
Food secure	1664.6 ± 35.8	0.17	1210.7 ± 28.1	<0.01	1568.4 ± 28.3	<0.01	1232.9 ± 24.1	<0.01	1422.4 ± 22.0	<0.01	1169.7 ± 17.7	<0.01
Food insecure	1537.6 ± 68.0	(0.29)	1055.8 ± 45.3	(0.20)	1348.7 ± 109.8	(0.17)	1088.4 ± 51.1	(0.12)	1161.3 ± 65.2	(0.01)	988.2 ± 60.6	(0.08)
Zinc, *mg*												
Food secure	14.3 ± 0.4	0.26	9.5 ± 0.2	0.03	14.1 ± 0.3	<0.01	9.9 ± 0.2	0.14	12.3 ± 0.2	<0.01	9.8 ± 0.2	0.02
Food insecure	13.2 ± 0.6	(0.42)	8.5 ± 0.4	(0.25)	11.1 ± 0.9	(0.02)	9.2 ± 0.5	(0.31)	9.3 ± 0.6	(<0.01)	8.4 ± 0.7	(0.32)
Potassium, *mg*												
Food secure	3567.4 ± 81.0	0.08	2717.4 ± 56.3	<0.01	3554.5 ± 59.1	0.02	2884.1 ± 41.8	<0.01	3422.6 ± 50.3	<0.01	2855.9 ± 39.1	0.03
Food insecure	3236.3 ± 138.6	(0.16)	2368.9 ± 93.2	(0.07)	3170.7 ± 220.1	(0.40)	2487.1 ± 97.2	(<0.01)	2784.2 ± 160.5	(<0.01)	2570.2 ± 148.7	(0.80)
Sodium, *mg*												
Food secure	4067.8 ± 114.1	0.88	2769.0 ± 78.1	0.29	3646.6 ± 79.9	0.01	2791.8 ± 53.6	<0.01	3364.4 ± 63.6	0.03	2583.9 ± 48.5	0.15
Food insecure	4015.1 ± 257.8	(0.74)	2568.0 ± 121.1	(0.39)	3105.8 ± 233.0	(0.09)	2410.4 ± 120.9	(0.02)	2891.8 ± 223.6	(0.09)	2398.9 ± 136.5	(0.63)

[1] Values are means ± SD

[2] Refer to Table 1 for *n* for each age/sex and food security subgroup.

[3] *P*-values were derived from ANOVA stratified by age/sex group and with Box-Cox transformed nutrient intakes as the dependent variables and dichotomous household food security status as the independent variable. Adjusted *P*-values were derived from multivariate ANOVA with income adequacy, respondent education, immigrant status, current daily smoking status, and household size variables included as covariates.

models (**Supplemental Table 2**). In contrast to the adult age/sex subgroups, fewer differences in macronutrient (Supplemental Table 2) and micronutrient (**Supplemental Table 3**) intakes by household food security status were observed; differences in micronutrient intakes that were apparent most often occurred among males in the 14–18 y age group (Supplemental Table 3). Somewhat fewer significant differences in micronutrient intake were observed between children classified as food secure or insecure based only on the child-referenced items (**Supplemental Table 4**). Household food insecurity was associated with higher energy density among males and females in the 9–13 y and 14–18 y age groups and a lower proportion of energy from protein for some subgroups of children (**Supplemental Table 5**). Fewer servings of fruits and vegetables were consumed by food-insecure children aged 1–3 y and males 14–18 y and fewer milk products were consumed by food-insecure children aged 1–3 y and 4–8 y (**Supplemental Table 6**). As with adults, the inclusion of covariates in the ANOVA models resulted in the attenuation

TABLE 5 Adults' mean energy density and macronutrient composition from first 24-h recall in relation to household food security status[1,2]

	Males 19–30 y		Females 19–30 y		Males 31–50 y		Females 31–50 y		Males 51–70 y		Females 51–70 y	
	Intake	*P*-value (adjusted)[3]	Intake	*P*-value (adjusted)[3]	Intake	*P*-value (adjusted)[3]	Intake	*P*-value (adjusted)[3]	Intake	*P*-value (adjusted)[3]	Intake	*P*-value (adjusted)[3]
Energy density, *kJ/g*												
Food secure	6.7 ± 0.02	0.07	6.3 ± 0.02	<0.01	6.7 ± 0.02	0.93	6.3 ± 0.02	0.04	6.3 ± 0.02	0.23	5.9 ± 0.01	0.74
Food insecure	7.1 ± 0.1	(0.27)	6.7 ± 0.1	(0.10)	6.7 ± 0.1	(0.92)	6.7 ± 0.04	(0.15)	6.7 ± 0.1	(0.52)	5.9 ± 0.1	(0.26)
Proportion of energy from protein, *%*												
Food secure	15.7 ± 0.3	0.15	15.7 ± 0.3	0.10	17.0 ± 0.2	<0.01	16.6 ± 0.3	0.38	17.0 ± 0.2	0.25	17.2 ± 0.2	0.05[4]
Food insecure	15.0 ± 0.5	(0.45)	14.7 ± 0.5	(0.44)	14.4 ± 0.5	(<0.01)	16.0 ± 0.6	(0.99)	16.1 ± 0.9	(0.82)	15.9 ± 0.7	(0.25)
Proportion of energy from carbohydrates, *%*												
Food secure	49.7 ± 0.5	0.71	51.9 ± 0.5	0.85	47.3 ± 0.5	<0.01	48.2 ± 0.5	<0.01	47.0 ± 0.4	<0.01	49.3 ± 0.4	<0.01
Food insecure	49.0 ± 1.7	(0.88)	51.8 ± 0.9	(0.75)	54.2 ± 1.6	(<0.01)	52.3 ± 1.4	(0.08)	51.4 ± 1.2	(0.04)	53.4 ± 1.5	(0.18)
Proportion of energy from fat, *%*												
Food secure	31.3 ± 0.4	0.15	30.4 ± 0.4	0.40	31.8 ± 0.4	<0.01	32.2 ± 0.4	0.09	31.6 ± 0.3	0.32	31.3 ± 0.3	0.12
Food insecure	29.7 ± 1.0	(0.03)	31.1 ± 0.8	(0.74)	28.1 ± 1.3	(0.03)	30.1 ± 1.2	(0.13)	30.3 ± 1.2	(0.76)	29.5 ± 1.2	(0.34)

[1] Values are means ± SD.

[2] Refer to Table 1 for *n* for each age/sex and food security subgroup.

[3] *P*-values were derived from ANOVA stratified by age/sex group and with Box-Cox transformed nutrient intakes as the dependent variables and dichotomous household food security status as the independent variable. Adjusted *P*-values were derived from multivariate ANOVA with income adequacy, respondent education, immigrant status, current daily smoking status, and household size variables included as covariates.

[4] *P*-value < 0.05 before rounding.

of some of the effects of household food security status on intakes (Supplemental Tables 2–6).

Among children, no prevalence of nutrient inadequacy >10% was observed for those 1–3 y and 4–8 y (**Supplemental Table 7**). Substantial prevalence estimates were observed for protein, vitamin A, magnesium, phosphorus, and zinc among children aged 9–13 y and 14–18 y and for folate among girls aged 14–18 y (Supplemental Table 7). Where prevalence estimates >10% were observed, the prevalence of inadequacy was typically higher among children or adolescents in food-insecure households, with the differences most marked for protein, vitamin A, and magnesium (Supplemental Table 7).

Discussion

Household food insecurity was associated with the consumption of poorer quality diets among adults, as indicated by systematically lower nutrient intakes and the consumption of fewer servings of milk products, fruits and vegetables, and in some cases, meat and meat alternates. These findings are consistent with previous U.S. research (11–13,19) demonstrating that household food insecurity is associated with dietary compromise for adults and are corroborated by U.S. studies documenting lower serum nutrient concentrations among adults in households characterized by food insecurity (37) or food insufficiency (13).

TABLE 6 Adults' consumption of foods from Canada's Food Guide to Healthy Eating food groups from first 24-h recall in relation to household food security status[1,2]

	Males 19–30 y		Females 19–30 y		Males 31–50 y		Females 31–50 y		Males 51–70 y		Females 51–70 y	
	Servings, *n*	*P*-value (adjusted)[3]	Servings, *n*	*P*-value (adjusted)[3]	Servings, *n*	*P*-value (adjusted)[3]	Servings, *n*	*P*-value (adjusted)[3]	Servings, *n*	*P*-value (adjusted)[3]	Servings, *n*	*P*-value (adjusted)[3]
Fruit and vegetables												
Food secure	5.5 ± 0.2	<0.01	4.8 ± 0.2	<0.01	5.2 ± 0.1	0.84	4.9 ± 0.1	<0.01	5.7 ± 0.2	0.04	5.2 ± 0.1	0.03
Food insecure	4.2 ± 0.4	(0.05[4])	3.5 ± 0.3	(0.02)	5.5 ± 0.9	(0.61)	3.8 ± 0.2	(<0.01)	4.6 ± 0.5	(0.26)	4.6 ± 0.4	(0.66)
Milk products												
Food secure	2.0 ± 0.1	<0.01	1.6 ± 0.1	0.02	1.6 ± 0.1	0.01	1.5 ± 0.1	0.03	1.4 ± 0.05	<0.01	1.3 ± 0.04	<0.01
Food insecure	1.4 ± 0.2	(<0.01)	1.2 ± 0.1	(0.53)	1.2 ± 0.2	(0.25)	1.3 ± 0.2	(0.20)	1.0 ± 0.2	(0.02)	1.0 ± 0.1	(0.02)
Meat and alternatives												
Food secure	4.9 ± 0.2	0.68	2.9 ± 0.1	0.52	5.2 ± 0.1	<0.01	3.4 ± 0.2	0.24	4.9 ± 0.1	0.02	3.5 ± 0.1	<0.01
Food insecure	5.1 ± 0.5	(0.97)	2.8 ± 0.2	(0.72)	3.8 ± 0.2	(0.02)	3.1 ± 0.2	(0.59)	3.9 ± 0.3	(0.35)	2.8 ± 0.3	(0.22)
Grain products												
Food secure	7.4 ± 0.2	0.87	5.5 ± 0.2	<0.01	6.8 ± 0.2	0.60	5.0 ± 0.1	0.28	5.8 ± 0.1	0.96	4.8 ± 0.1	0.06
Food insecure	7.2 ± 0.5	(0.63)	4.4 ± 0.2	(0.09)	6.6 ± 0.6	(0.58)	4.7 ± 0.3	(0.42)	5.9 ± 0.4	(0.64)	4.2 ± 0.3	(0.03)

[1] Values are means ± SD.

[2] Refer to Table 1 for *n* for each age/sex and food security subgroup.

[3] *P*-values were derived from ANOVA stratified by age/sex group and with Box-Cox transformed nutrient intakes as the dependent variables and dichotomous household food security status as the independent variable. Adjusted *P*-values were derived from multivariate ANOVA with income adequacy, respondent education, immigrant status, current daily smoking status, and household size variables included as covariates.

[4] *P*-value < 0.05 before rounding.

TABLE 7 Prevalences of inadequacy among adults for nutrients for which an EAR has been set[1,2]

	Prevalence of inadequacy												
	Protein[3]	Vitamin A	Vitamin C	Thiamin	Riboflavin	Niacin	Vitamin B-6	Folate	Vitamin B-12	Iron[4]	Magnesium	Phosphorus	Zinc
Males, 19–30 y													
Food secure	<10	46 (41–50)	18 (11–24)	<10	<10	<10	<10	<10	<10	<10	34 (30–39)	<10	<10
Food insecure	16 (10–22)	60 (38–82)	22 (0–78)	<10	<10	<10	<10	<10	<10	<10	42 (33–52)	<10	16 (0–33)
Females, 19–30 y													
Food secure	24 (22–27)	39 (35–44)	14 (8–20)	<10	<10	<10	<10	17 (6–27)	10 (0–21)	11	34 (29–39)	<10	12 (3–20)
Food insecure	43 (37–48)	69 (55–83)	<10	<10	<10	<10	23 (0–48)	26 (0–85)	17 (0–74)	18	55 (43–67)	<10	28 (16–40)
Males, 19–30 y													
Food secure	14 (13–17)	45 (42–48)	30 (26–34)	<10	<10	<10	<10	<10	<10	<10	43 (40–45)	<10	10 (4–17)
Food insecure	32 (26–38)	47 (38–55)	23 (0–52)	<10	13 (6–21)	<10	18 (5–31)	11 (0–27)	14 (0–36)	<10	65 (55–75)	<10	46 (39–54)
Females, 31–50 y													
Food secure	22 (20–24)	34 (29–38)	24 (20–28)	<10	<10	<10	16 (11–20)	17 (10–25)	<10	18	36 (33–38)	<10	15 (10–20)
Food insecure	37 (32–42)	50 (43–57)	34 (26–43)	15 (4–26)	<10	<10	27 (20–35)	38 (30–46)	30 (22–39)	23	53 (47–59)	<10	17 (2–32)
Males, 51–70 y													
Food secure	25 (23–27)	41 (37–44)	28 (24–32)	<10	<10	<10	11 (6–17)	12 (7–16)	<10	<10	53 (51–55)	<10	23 (16–29)
Food insecure	41 (34–48)	61 (52–69)	43 (32–53)	<10	17 (6–27)	<10	32 (14–49)	19 (0–40)	28 (14–43)	<10	76 (66–87)	<10	58 (49–68)
Females, 51–70 y													
Food secure	21 (20–23)	32 (27–37)	16 (12–21)	<10	<10	<10	17 (7–27)	23 (17–28)	<10	<10	36 (34–39)	<10	<10
Food insecure	57 (51–63)	50 (42–58)	33 (23–43)	23 (10–36)	17 (3–30)	<10	41 (31–50)	57 (48–65)	21 (0–66)	<10	56 (49–62)	15 (3–26)	16 (0–85)

[1] Values are % (95% CI). Prevalences of inadequacy were calculated using the EAR cut-point approach (with the exception of iron for which the probability approach was used), with analyses stratified by age/sex group and household food security status.

[2] Refer to Table 1 for *n* and number of 2nd 24-h recalls for each age/sex and food security subgroup.

[3] Prevalences of inadequacy for protein were estimated for respondents for whom measured anthropometric data were available.

[4] Because prevalence estimates for iron were calculated using the probability approach, confidence intervals comparable to those for nutrients assessed using the EAR cut-point method could not be computed.

We noted few differences in young children's nutrient intakes in relation to household food security status, but those in food-insecure subgroups consumed fewer servings of fruits and vegetables and milk products, suggesting some constraints on their food intakes. Among older children in food-insecure households, there were some indications of lower nutrient intakes. A notable finding among children is the positive association between household food insecurity and energy density among some subgroups, which could impact weight status over time if household food insecurity and its associated dietary patterns are chronic experiences.

Although the inclusion of potentially confounding covariates attenuated the effect of household food insecurity on intakes of some nutrients, a number of effects of household food security status remained significant. One possible explanation for the loss of significance, particularly in the analyses for women 19–30 y, is the strong correlation between food insecurity and other independent variables in the model (most notably income adequacy and education). This situation, known as colinearity, can result in a loss of significance for individual parameters by inflating the estimated variances of the regression coefficients (38).

Substantial prevalences of inadequacy were observed for adults in food-insecure households across a wide spectrum of nutrients. Adolescents in food-insecure households also had relatively high prevalences of inadequacy for some nutrients, notably vitamin A, protein, and magnesium. In almost all cases where a prevalence of inadequacy in excess of 10% was observed, the prevalence was higher among those in food-insecure households. These results suggest that compromises in dietary intakes in the context of household food insecurity are of sufficient gravity to heighten the vulnerability of some age/sex groups to nutrient inadequacies. Our examination of prevalences of nutrient inadequacies extends the understanding of nutritional vulnerability that can be gleaned from the results of group mean comparisons. Even though food or nutrient intakes may differ significantly by household food security status, it does not necessarily follow that the usual intakes of those in food-insecure households are so low as to be associated with increased risk of nutrient inadequacies, and the reverse is also true. For example, women 51–70 y in food-insecure households had more than twice the prevalence of inadequacy for vitamin B-6 of women in food-secure households, but no difference in group means was observed.

We have not applied statistical tests to compare estimates of prevalence of nutrient inadequacies between food-secure and -insecure groups. The degree of overlap of the CI around the estimates for the food-secure and food-insecure subgroups for each age/sex group provides some indication of the extent to which differences are significant. However, the standard errors and resulting CI are underestimates of the true error associated with the prevalence estimates due to the effect of the clustering in the survey design and the variability associated with both the EAR and the collection of dietary intake data (16). Our examination of nutrient inadequacies is also limited by the small numbers of respondents in food-insecure households in some age/sex groups and the smaller numbers of replicate 24-h recalls for respondents in these groups. The instability of estimates derived from samples with insufficient replicates is highlighted by the extraordinarily wide CI around prevalence estimates for some nutrients for some subgroups. There are some indications that individuals' intakes are sensitive to perturbations in household resources (39,40), suggesting that a greater number of replicate observations is likely required to obtain a stable estimate of within-person variation among groups whose dietary intakes are affected by household food insecurity. Without oversampling of population subgroups vulnerable to household food insecurity and/or the completion of replicate 24-h recalls by a larger proportion of survey samples, it is impossible to overcome this limitation.

Problems of underreporting are ubiquitous in dietary intake surveys (16) and CCHS 2.2 is likely no exception. In this study, we used the EI:EER ratio to assess reporting quality, recognizing that EI:EER does not provide an indication of the quality of data for nutrients. Although this assessment was limited by the lack of physical activity data at the level of detail specified in the DRI energy report (30) and the absence of measured height and weight values for some respondents, the mean ratios were <1 for all adult and adolescent subgroups, suggesting underreporting. Whereas differences observed in mean intakes and prevalences of inadequacy might be attributable to a greater degree of underreporting among respondents in food-insecure households, EI:EER differed significantly in relation to food security status in only 2 subgroups (females 19–30 y and 51–70 y). These differences might indicate greater underreporting among women in food-insecure households, but they may also be a reflection of the food compromises associated with food insecurity (17). This is implied for females 51–70 y by the significantly lower intakes of fruit and vegetables, milk products, and meat and alternates and the high prevalence of inadequacy noted across a spectrum of micronutrients.

We did not observe differences in EI:EER by food security status among children (except for the positive association with food insecurity among 4–8 y olds after adjusting for potential confounders) and the mean values for those aged 4–13 y do not suggest substantial under- or overreporting of EI. However, we were unable to differentiate children's activity levels. Thus, EER was underestimated and EI:EER overestimated for children with more than sedentary levels of activity, making it difficult to gauge the quality of energy reporting for these subgroups. Although reporting problems may explain why more differences were not found in children's nutrient intakes, an alternate explanation lies in the continuum of food insecurity whereby the quality and quantity of adults' intakes are typically affected before children's intakes are compromised (21,23,24).

This study indicates that the phenomenon of food insecurity, measured routinely in population surveys in both Canada and the US, is a marker of dietary compromises among adults and adolescents that are of sufficient magnitude to heighten risk of nutrient inadequacies. The nutritional vulnerability associated with food insecurity highlights the urgent need for policy responses to address the root causes. Further, the poorer dietary intakes observed among Canadians living in food-insecure households are particularly worrisome if they represent long-term dietary patterns, speaking to the need for longitudinal research to elucidate the chronicity of food insecurity and its nutritional consequences.

Acknowledgments

We thank George Beaton for assistance with the statistical approaches used in this study, including the development of the syntax for the assessment of prevalence of adequacy for iron; Didier Garriguet for advice on the use of SIDE-IML with this dataset; and Naomi Dachner for assistance with editing of the manuscript.

Literature Cited

1. Office of Nutrition Policy and Promotion. Income-related household food security in Canada. Ottawa: Health Canada; 2007. Report No.: H164–42/2007E.
2. McIntyre L, Connor SK, Warren J. Child hunger in Canada: results of the 1994 National Longitudinal Survey of Children and Youth. Can Med Assoc J. 2000;163:961–5.
3. Che J, Chen J. Food insecurity in Canadian households. Health Rep. 2001;12:11–22.
4. Vozoris N, Tarasuk V. Household food insufficiency is associated with poorer health. J Nutr. 2003;133:120–6.
5. Ledrou I, Gervais J. Food insecurity. Health Rep. 2005;16:47–51.
6. Jacobs Starkey L, Kuhnlein HV. Montreal food bank users' intakes compared with recommendations of Canada's Food Guide to Healthy Eating. Can J Diet Pract Res. 2000;61:73–5.
7. Tarasuk VS. Household food insecurity with hunger is associated with women's food intakes, health, and household circumstances. J Nutr. 2001;131:2670–6.
8. Badun C, Evers S, Hooper M. Food security and nutritional concerns of parents in an economically disadvantaged community. J Can Diet Assoc. 1995;56:75–80.
9. Jacobs Starkey L, Gray-Donald K, Kuhnlein HV. Nutrient intake of food bank users is related to frequency of food bank use, household size, smoking, education and country of birth. J Nutr. 1999;129:883–9.
10. McIntyre L, Raine K, Glanville T, Dayle JB. Hungry mothers of barely fed children. Halifax (Canada): NHRDP; 2001. Report No.: NHRDP No. 6603–1550–002.
11. Cristofar SP, Basiotis PP. Dietary intakes and selected characteristics of women ages 19–50 years and their children ages 1–5 years by reported perception of food sufficiency. J Nutr Educ. 1992;24:53–8.
12. Rose D, Oliveira V. Nutrient intakes of individuals from food-insufficient households in the United States. Am J Public Health. 1997; 87:1956–61.
13. Dixon LB, Winkleby MA, Radimer KL. Dietary intakes and serum nutrients differ between adults from food-insufficient and food-sufficient families: Third National Health and Nutrition Examination Survey, 1988–1994. J Nutr. 2001;131:1232–46.
14. Lee JS, Frongillo EA. Nutritional and health consequences are associated with food insecurity among US elderly persons. J Nutr. 2001;131:1503–9.
15. Casey PH, Szeto K, Lensing S, Bogle M, Weber J. Children in food-insufficient, low-income families. Arch Pediatr Adolesc Med. 2001;155: 508–14.
16. Institute of Medicine. Dietary reference intakes: applications in dietary assessment. Washington, DC: National Academy Press; 2000.
17. Tarasuk VS, Beaton GH. Women's dietary intakes in the context of household food insecurity. J Nutr. 1999;129:672–9.
18. McIntyre L, Glanville T, Raine KD, Anderson B, Battaglia N. Do low-income lone mothers compromise their nutrition to feed their children? Can Med Assoc J. 2003;168:686–91.
19. Devaney B, Kim M, Carriquiry A, Camano-Garcia G. Assessing the nutrient intakes of vulnerable subgroups. Washington, DC: USDA, Economic Research Service; 2005. Report No.: CCR11.
20. Statistics Canada. Canadian Community Health Survey (CCHS) Cycle 2.2 (2004) Nutrition: general health and 24-hour dietary recall components user guide. Ottawa (ON): Statistics Canada; 2006.
21. Bickel G, Nord M, Price C, Hamilton WL, Cook J. Guide to measuring household food security. Alexandria (VA): USDA, Food and Nutrition Service, Office of Analysis, Nutrition and Evaluation; 2000.
22. Wilde PE. Differential response patterns affect food-security prevalence estimates for households with and without children. J Nutr. 2004;134: 1910–5.
23. Radimer KL, Olson CM, Campbell CC. Development of indicators to assess hunger. J Nutr. 1990;120:1544–8.
24. Radimer KL, Olson CM, Greene JC, Campbell CC, Habicht J-P. Understanding hunger and developing indicators to assess it in women and children. J Nutr Educ. 1992;24:S36–45.
25. Health Canada. Canada's food guide to healthy eating. Ottawa(ON): Minister of Public Works and Government Services Canada; 1997. Report No.: H39–252/1992E.
26. Ledikwe J, Blanck H, Khan L. Dietary energy density determined by eight calculations methods in a nationally representative United States population. J Nutr. 2005;135:273–8.
27. Tukey J. Exploratory data analysis. Cambridge (MA): Addison-Wesley; 1977.
28. Rennie K, Coward A, Jebb S. Estimating under-reporting of energy intake in dietary surveys using an individualised method. Br J Nutr. 2007;97:1169–76.
29. Ward H, Tarasuk V, Mendelson R. Adiposity, education and weight loss effort are independently associated with energy reporting quality in the Ontario Food Survey. Public Health Nutr. 2007;10:803–9.

30. Institute of Medicine. Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids. Washington, DC: National Academy Press; 2005.
31. Bilodeau M, Brenner D. Theory of multivariate statistics. New York: Springer; 1999.
32. Institute of Medicine. Dietary reference intakes for calcium, phosphorus, magnesium, vitamin D, and fluoride. Washington, DC: National Academy Press; 1997.
33. Institute of Medicine. Dietary reference intakes for thiamin, riboflavin, niacin, vitamin B6, folate, vitamin B12, pantothenic acid, biotin, and choline. Washington, DC: National Academy Press; 1998.
34. Institute of Medicine. Dietary reference intakes for vitamin C, vitamin E, selenium, and carotenoids. Washington, DC: National Academy Press; 2000.
35. Institute of Medicine. Dietary reference intakes: vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc. Washington, DC: National Academy Press; 2000.
36. Institute of Medicine. Dietary reference intakes for water, potassium, sodium, chloride, and sulfate. Washington, DC: National Academy Press; 2004.
37. Bhattacharya J, Currie J, Haider S. Poverty, food insecurity, and nutritional outcomes in children and adults. J Health Econ. 2004;23:839–62.
38. Kleinbaum DG, Kupper LL, Muller KE, Nizam A. Applied regression analysis and other multivariable methods. 3rd ed. Pacific Grove (CA): Duxbury Press; 1998.
39. Matheson DM, Varady J, Varady A, Killen JD. Household food security and nutritional status of Hispanic children in the fifth grade. Am J Clin Nutr. 2002;76:210–7.
40. Tarasuk V, McIntyre L, Li J. Low-income women's dietary intakes are sensitive to the depletion of household resources in one month. J Nutr. 2007;137:1980–7.