Community and International Nutrition

Household Food Insufficiency Is Associated with Poorer Health

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ABSTRACT   The purposes of this study were to estimate the prevalence of household food insufficiency in Canada, to identify sociodemographic characteristics of households most likely to report food insufficiency and to examine the relationship between food insufficiency and physical, mental and social health. These objectives were achieved through an analysis of data from the 1996/1997 National Population Health Survey. An estimated 4% of Canadians, 1.1 million people, were found to be living in food-insufficient households. Single-parent families, households reporting their major source of income as welfare, unemployment insurance or workers' compensation, those who did not own their own homes and households in Western Canada were more likely to report food insufficiency. The likelihood of reporting food insufficiency increased dramatically as income adequacy deteriorated. Individuals from food-insufficient households had significantly higher odds of reporting poor/fair health, of having poor functional health, restricted activity and multiple chronic conditions, of suffering from major depression and distress, and of having poor social support. Individuals in food-insufficient households were also more likely to report heart disease, diabetes, high blood pressure and food allergies. Men in food-insufficient households were less likely to be overweight; after adjusting for potentially confounding variables, no other associations were found between food insufficiency and body mass index. These findings suggest that food insufficiency is one dimension of a more pervasive vulnerability to a range of physical, mental and social health problems among households struggling with economic constraints.   J. Nutr. 133: 120–126, 2003.

KEY WORDS: • *food insecurity* • *health status* • *welfare* • *body mass index* • *Canada*

Food insecurity has become recognized as a public health issue in Canada, but our understanding of the scope and nature of this problem remains limited by the lack of population-level data. Unlike the United States, Canada has no national monitoring system for food insecurity. Until recently, the primary indication of household food insecurity was the large and continually growing numbers of Canadians seeking charitable food assistance programs from ad hoc community programs, called "food banks." Our understanding of the phenomenon came from community-based surveys and studies of food bank users (1–5). Indeed, the problem of food insecurity was popularly equated with food bank use, and developing effective "alternatives to food banks" became the raison d'être for many community-based responses to food insecurity (6). Recently, analyses of data from the 1994 National Longitudinal Survey of Children and Youth (7) and the 1998–1999 National Population Health Survey (NPHS)[2] (8) have begun to furnish population-based prevalence estimates for various indicators of household food insecurity in Canada and identify the sociodemographic and health characteristics of families reporting food problems (7,8). Although these studies are limited by the lack of comprehensive measures of household food insecurity, they have greatly expanded our understanding of the problem

and pinpointed the particular vulnerability of some population subgroups, notably welfare recipients and single-parent families. Consistent with the results of U.S. population surveys (9–15), these analyses have also highlighted the interrelationship between markers of food insecurity and poor health.

This study was undertaken to further contribute to an understanding of the scope and nature of food insecurity in Canada through an analysis of data from the 1996–1997 NPHS. Our working hypothesis was that indicators of household food insecurity, such as the measure of food insufficiency included in the 1996–1997 NPHS, denote households that are experiencing a more pervasive level of vulnerability. Our specific objectives were to estimate the prevalence of household food insufficiency, identify sociodemographic characteristics of households most likely to report food insufficiency, and examine the likelihood that individuals in households reporting food insufficiency would report poor physical, mental and social health, and selected chronic health conditions.

MATERIALS AND METHODS

Data.   This study was conducted with data from the public use microdata health file for the household survey of the Cycle 2 (1996/1997) NPHS. The NPHS is an ongoing survey conducted by Statistics Canada to collect both longitudinal and cross-sectional data on the health of Canadians. A detailed description of the survey design and methodology appears elsewhere (16–19). The sample for the household survey component of NPHS includes household residents in all 10 provinces, with the exclusion of populations on Indian Reserves, Canadian Armed Forces Bases, the Yukon and Northwest

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Territories, and some remote areas in Ontario and Quebec, long-term residents of hospitals or residential care facilities, and persons who are homeless. In this survey, limited individual and household-level socioeconomic and health information was collected from one knowledgeable person from each participating household (210,377 households in total). In 39% of these households, detailed health-related data were collected on one randomly selected individual, with proxy reporting employed for persons who because of age or other reasons were unable to answer questions themselves. Almost all interviews (99%) were conducted by telephone, but sample weights were adjusted for the bias associated with not selecting households without telephones (an estimated 2% of the Canadian population). The survey was developed, tested and administered in both English and French; ad hoc, oral translations of the instrument into other languages occurred when the respondent could not complete the interview in either English or French. However, 99.7% of respondents completed the survey in either English or French (20). These data comprise the "health file" of the NPHS and are available for 81,804 respondents (50.5% female, 14.1% <12y old) (17).

Food insufficiency. Cycle 2 of the NPHS included three questions to explore issues of household food insecurity. Household respondents were asked if, over the past 12 mo, their household had "ever run out of money to buy food." Those who responded affirmatively were then asked two additional questions: *1)* "Did anyone in your household receive food from a food bank, soup kitchen, or other charitable agency?" *2)* "Which of the following best describes the food situation in your household? a) always enough food to eat; b) sometimes not enough food to eat; or c) often not enough food to eat." The latter question was drawn from the food sufficiency question developed for the Third National Health and Nutrition Examination Survey (21–24) and represents a slight modification of the USDA food sufficiency indicator used in other dietary surveys (10,22,23). The validity of this measure is indicated by the strong associations between household food insufficiency and lower reported energy and nutrient intakes (10,22) and between household food insufficiency and income-based measures of poverty (10,25).

In this study, households who responded that they sometimes or often did not have enough food to eat (3.9% of the sample) were classified as "food insufficient"; those who reported that they never ran out of money to buy food (93.4% of the sample) or did so, but always had enough food to eat (2.5% of the sample) were deemed "food sufficient." This operational definition of food insufficiency is similar to that used in other research (9,10,22,25), but the inclusion of a screening question about "running out of food" in the NPHS means that our measure of food insufficiency is likely more conservative than others. Nonetheless, it may be a better proxy for food insecurity than the food insufficiency question alone because our measure incorporates the aspect of insufficient resources. The 0.2% of respondents who did not know or refused to respond to the questions were excluded from the analyses presented here. Our final analytic sample thus consisted of 81,581 respondents.

Sociodemographic and health variables. Because food insufficiency was assessed at the household level, we limited our examination of the sociodemographic variables to those also measured at the household level. Household type was defined as single person, single parent with children under 25 y, couple without children, couple with children under 25 y with or without others, or other household arrangements. Region of residence at the time of data collection was defined as Atlantic Canada (Newfoundland, Prince Edward Island, Nova Scotia, and New Brunswick), Central Canada (Quebec and Ontario) or Western Canada (Manitoba, Saskatchewan, Alberta, and British Columbia).

Three variables were available to us to describe the material circumstances of the household. Household income was classified in terms of a five-level categorical variable describing income adequacy; this variable, constructed by Statistics Canada, was based on information about gross total household income in the past 12 mo and family size (17). The category definitions are presented in **Appendix 1**. It is important to note that household incomes in the "lowest income" and "lower middle income" groups, and some in the "middle income" groups, fall below Statistics Canada's Low Income Cut-Offs (a commonly used measure of poverty in Canada) (26). The eco-

nomic status of the household was further described by a dichotomous variable indicating whether a member of the household owned the dwelling (even if it was still being paid for) in which they lived. The main source of household income is categorized as employment, welfare/unemployment insurance/workers' compensation, seniors' benefits, other sources or not applicable/not stated. Although the main source of income for 76% of those in the welfare/unemployment insurance/workers' compensation category was welfare (20), the data available to us did not permit differentiation of these households.

Multiple measures of health were assessed for the one randomly selected person in each participating household. General health, and physical, mental, and social dimensions of health were assessed through a self-rated health scale, a functional health index, restricted activity status, number of chronic conditions, a depression index, a distress index and a social support index. All measures captured self-reported health. For each measure, we constructed a dichotomous variable to differentiate individuals with responses indicative of poor health. Detailed descriptions of the variables and cut-points used to define poor health are presented in **Appendix 2**.

We also considered four chronic conditions for which dietary behaviors have been implicated in the etiology or management, i.e., heart disease, diabetes, high blood pressure and food allergies. Respondents were classed as having a particular condition only if they reported that it had lasted or was expected to last for 6 mo or longer and that it had been diagnosed by a health professional. Heart disease and food allergies were assessed for respondents of all ages, but only respondents ≥12 y old were asked if they had diabetes or high blood pressure.

In addition, we considered body mass index (BMI). Body weight and height were collected through self-reports and were used to construct the BMI for respondents ages 20–64 y, excluding pregnant women. We classified respondents' BMI according to the WHO criteria (35). Underweight was defined as a BMI < 19.0 kg/m^2, normal weight was defined as a BMI of 19.0–24.9 kg/m^2, overweight was defined as a BMI of 25.0–29.9 kg/m^2, obesity (Obese Class I) was defined as a BMI of 30.0–34.9 kg/m^2, whereas morbid obesity (Obese Class II-III) was defined as a BMI ≥ 35.0 kg/m^2.

Statistical methods. All analyses were performed with SAS version 8.0 (SAS Institute, Cary, NC). Descriptive cross-tabulations were calculated to examine the associations between food insufficiency and the selected household characteristics. Multiple logistic regression was used to describe the relationship between household food insufficiency and the household-level sociodemographic characteristics. This approach enabled us to identify the relative importance of each variable, recognizing that many were interrelated (e.g., low income, single parenthood, not owning a dwelling, being on welfare).

Multiple logistic regression was used to estimate the odds that a randomly selected individual in a household characterized by food insufficiency would report poor health (across the broad spectrum of measures outlined above) and selected chronic health conditions. Individuals in food-sufficient households were used as the reference category for calculations of odds ratios. Age group, sex, education level and household income adequacy were included in all models to control for the potentially confounding effects of these variables on observed associations. Age and sex were included because of the wide spectrum of ages in our sample (17) and the research documenting the age- and sex-related differences in the various health measures considered (30,32,33,36,37). Significant associations have also been documented between income adequacy and education level and the various health measures considered here (28,33,36–38). Because food insufficiency is a particular problem for low income households, and education is tightly linked to income, these two sociodemographic variables were included in the regression models as well, to ensure that any observed associations with food insufficiency were not simply marking the well-documented relationship between low socioeconomic status and poor health. It is emphasized that unlike some other research in this area (e.g., 13–15), our analysis was not intended to explore hypothesized causal relationships between household food insufficiency and specific health outcomes. Thus, other sociodemographic variables associated with food insufficiency (e.g., single parenthood) and individual-level characteristics that might link to the health measures considered (e.g., smoking status, BMI, alcohol or

drug use) were not included in our regression model. Our objective was simply to estimate the odds of someone in a food-insufficient household reporting health problems.

A sequence of three logistic regression models was run to examine the association between household food sufficiency and BMI category. Individuals in food-sufficient households were used as the reference category for calculations of odds ratios. All models were stratified by sex. Unadjusted odds ratios were obtained from the first model. To adjust for known sociodemographic influences on BMI, age group, education level and income adequacy (24,39–43) were included in the second model. Because our analyses (reported here) revealed strong associations between household food insufficiency and poor health, and BMI is significantly associated with functional health (measured by the Health Utility Index) (44), a third regression model was run that included Health Utility Index score to control for the potentially confounding effects of chronic ill health.

The NPHS employs a complex sampling design, with stratification and multiple stages of selection, and unequal probabilities of selecting respondents (17). To account for the unequal probabilities of selection, all sample weights were rescaled before analysis by dividing the original weight by the average weight of respondents included in the specific analysis (17). To account for the effects of stratification and multiple stages of selection on variance estimates, all confidence intervals were calculated using bootstrap resampling techniques, with a set of 500 bootstrap weights created by Statistics Canada to reflect the sampling design used in the survey (45). All of the results presented here reflect weighted estimates.

RESULTS

In the sample, 3204 households were food insufficient; this represents an estimated 4.0% of the Canadian population, or 1,122,727 million people. Only 35.4% of food-insufficient households reported having received food from a food bank, soup kitchen or other charitable agency in the past year.

The sociodemographic profile of food-insufficient households differed considerably from the profile of food-sufficient households (**Table 1**). In particular, single-parent families, households reporting their major source of income as welfare, unemployment insurance or workers' compensation, those who did not own their own homes and households in Western Canada had greater odds of reporting food insufficiency. The likelihood of reporting food insufficiency increased dramatically as income adequacy deteriorated (Table 1). Although 22.3% of households in the lowest income adequacy category were food insufficient, it was relatively rare for households to report such extremely low incomes. Thus the majority of food-insufficient households were in the lower middle and middle income adequacy groups.

Individuals in food-insufficient households had significantly higher odds of rating their health as poor or fair, of having restricted activity, of having poor functional health, of suffering from multiple chronic conditions, of having major depression and distress, and of having poor social support compared with those in food-sufficient households (**Table 2**). Individuals in food-insufficient households were also significantly more likely to report having heart disease, diabetes, high blood pressure and food allergies (Table 2).

When crude odds ratios were examined, men in food-insufficient households appeared more likely to be underweight and normal weight, and less likely to be overweight than men in food-sufficient households; women in food-insufficient households were less likely to be normal weight and more likely to be

TABLE 1

Sociodemographic characteristics of the study sample by food sufficiency status[1]

	n	% Food sufficient (n = 78,377)	% Food insufficient (n = 3204)	Adjusted OR for reporting food insufficiency (95% CI)[2]
Area of residence				
Central Canada	50,926	96.4	3.6	1.0
Atlantic Canada	6,580	94.7	5.3	1.3 (1.0–1.6)
Western Canada	24,075	95.7	4.3	1.5 (1.3–1.8)
Household type				
Couple with children <25 y old, with or without others	42,584	97.3	2.7	1.0
Single	9,034	95.3	4.8	0.7 (0.6–0.9)
Single parent, children <25 y old	5,893	83.5	16.5	1.9 (1.4–2.5)
Couple alone	15,329	98.4	1.6	0.9 (0.7–1.1)
Other household types	8,765	95.3	4.7	1.3 (1.0–1.6)
Not stated	13	89.2	10.8	2.5 (0.0–61.3)
Own dwelling				
Yes	59,293	98.3	1.7	1.0
No	21,757	89.9	10.1	2.5 (2.1–3.0)
Don't know/refused/not stated	531	97.3	2.7	1.7 (1.0–2.9)
Main source of household income				
Employment	60,284	97.6	2.4	1.0
Welfare/unemployment insurance/workers' compensation	4,548	71.6	28.4	3.0 (2.4–3.7)
Seniors' benefits	10,866	98.1	1.9	0.5 (0.4–0.7)
Other source	2,111	91.9	8.1	1.3 (0.9–1.9)
Not applicable/not stated	3,808	97.3	2.7	0.9 (0.6–1.3)
Income adequacy				
Lowest income	3,215	77.8	22.3	12.8 (9.2–17.9)
Lower middle income	8,010	85.5	14.5	9.4 (7.2–12.4)
Middle income	21,695	96.3	3.7	4.1 (3.1–5.3)
Upper middle income	26,132	99.2	0.8	1.0
Highest income	10,270	99.9	0.1	0.2 (0.1–0.4)
Not stated	12,258	97.5	2.5	2.9 (2.2–3.9)

[1] Abbreviations: OR, odds ratio; CI, confidence interval.
[2] Adjusted for other variables listed in table.

TABLE 2

Odds of individuals in food insufficient households reporting poor general, physical, mental, or social health and selected chronic conditions[1]

	n (%)[2]	Adjusted OR[3]	95% CI
General health			
Poor/fair self-rated health	6,857		
Food sufficient	(8.0%)	1.0	
Food insufficient	(19.0%)	2.9	2.4–3.4
Poor functional health	8,691		
Food sufficient	(10.5%)	1.0	
Food insufficient	(24.0%)	3.0	2.5–3.7
Physical health			
Restricted activity	12,273		
Food sufficient	(14.5%)	1.0	
Food insufficient	(28.6%)	2.7	2.3–3.3
Multiple chronic conditions	23,390		
Food sufficient	(26.9%)	1.0	
Food insufficient	(41.9%)	2.8	2.3–3.4
Mental health			
Major depression	2,965		
Food sufficient	(3.8%)	1.0	
Food insufficient	(15.6%)	3.5	2.9–4.4
Distress	7,486		
Food sufficient	(9.9%)	1.0	
Food insufficient	(31.8%)	2.9	2.4–3.5
Social health			
Poor social support	9,248		
Food sufficient	(12.9%)	1.0	
Food insufficient	(22.0%)	1.7	1.3–2.1
Selected chronic conditions			
Heart disease	2,831		
Food sufficient	(3.4%)	1.0	
Food insufficient	(4.7%)	2.5	1.6–3.8
Diabetes	2,346		
Food sufficient	(3.2%)	1.0	
Food insufficient	(3.5%)	1.8	1.2–2.6
High blood pressure	7,351		
Food sufficient	(10.1%)	1.0	
Food insufficient	(8.6%)	1.6	1.2–2.1
Food allergies	5,467		
Food sufficient	(6.6%)	1.0	
Food insufficient	(10.7%)	1.7	1.3–2.3

[1] Abbreviations used: OR, odds ratio; CI, confidence interval.

[2] Numbers represent respondents who reported the condition. Calculations omit non-respondents and those for whom the item was not applicable.

[3] Adjusted for age group, sex, education level and income adequacy.

morbidly obese (**Table 3**). After adjusting for the potentially confounding effects of age, education, and income adequacy, the only association that remained significant was that men in food-insufficient households were less likely to be overweight. Adjusting for the potentially confounding effects of functional health did not change these results.

DISCUSSION

This study provides a crude estimate of the 1996–1997 prevalence of household food insufficiency in Canada (4%), based on a two-part, household-level indicator of quantitative food deprivation. Given the systematic exclusion of aboriginal people living on reserves and homeless people from the NPHS, this must be an underestimate of the true prevalence of food insufficiency. Interpretation of these data is further limited by the narrow focus of this assessment. A more comprehensive measure of food insecurity, including an assessment of the temporality and severity of quantitative food deprivation as well as an assessment of qualitative compromises in food selection, uncertainty regarding food supplies and the acceptability of foods consumed, would be required to characterize fully the extent and severity of food insecurity in Canada. To date, population-level assessments of food security in this country have been limited by the use of "red flag" approaches to measurement (i.e., individual items that provide some indication of vulnerability but are not designed to be scaled or grouped (46), and by the inclusion of different indicators on different surveys. In the subsequent cycle of the NPHS, 2 y later, food insecurity was indicated by an affirmative response to at least one of three questions indicating worry about not having enough to eat, compromise in the quality or variety of foods eaten, and not having enough to eat (8). Given the greater breadth of experiences encompassed in the 1998–1999 survey questions, and the use of a screening question in 1996–1997, it is not surprising that the later survey yielded a food insecurity prevalence estimate of 10% (vs. 4% food insufficient in the present study). The differences in measurement make it impossible to draw any inference about changes over time.

Our finding that the odds of food insufficiency increase with increasing income inadequacy is consistent with other examinations of the interrelationship between income-based measures of poverty and indicators of food insecurity in Canada (7,8,47,48) and measures of food insufficiency (10,11,25) and hunger and food insecurity (49–52) in the United States. In this study and others (7,8), indicators of household food insecurity appear to track other major indicators of poverty in Canada such as welfare and single parenthood (26,53). Income-expense comparisons have highlighted how the affordability of a nutritious diet may be problematic for households supported by welfare (54,55). A recent analysis of data from the 1994 National Longitudinal Survey of Children and Youth revealed that families who reported child hunger (a relatively severe manifestation of food insecurity) were 13 times more likely to report income from social assistance than those who did not report child hunger (7). Canada-U.S. differences in welfare policies and programs limit the comparability of findings across countries, but it is noteworthy that welfare recipients in the United States are also at high risk for food insecurity. In a recent study of welfare recipients in Michigan, almost one quarter reported that they sometimes or often did not have enough to eat (9). After adjusting for potentially confounding variables, Cook et al. (56) found that children in families in the United States whose welfare benefits were terminated or reduced as a result of recent welfare reforms were 1.5 times more likely to be food insecure.

Only about one third of food-insufficient households in this survey reported receiving food from a food bank, soup kitchen or other charitable agency in the past year. Consistent with other research on the association between food insecurity and the use of food assistance programs (57), this finding suggests that charitable food assistance utilization is a relatively poor marker of food insufficiency, underestimating its true prevalence. The low number of food-insufficient households using charitable food programs is not surprising given that in Canada these programs are typically ad hoc, extra-governmental, community initiatives and not matters of entitlement (58). Program access varies widely across communities. Further, individuals may be deterred from seeking assistance because of the social stigma associated with food charity (5,59–63) and the limited quantity and quality of food sometimes available to clients in these programs (64,65).

Household food insufficiency was significantly associated

TABLE 3

Odds of men and women in food insufficient households having a body mass index (BMI) indicative of underweight, normal weight, overweight, obesity or morbid obesity[1]

	Underweight	Normal weight	Overweight	Obesity	Morbid obesity
Men					
BMI, kg/m^2	<19.0	19.0–24.9	25.0–29.9	30.0–34.9	≥35.0
n	296	10,354	11,656	2,879	630
Food sufficient, %	1.1	39.8	45.6	11.1	2.4
OR	1.0	1.0	1.0	1.0	1.0
Food insufficient, %	2.9	50.1	30.6	12.8	3.5
Unadjusted OR (95% CI)	2.8 (1.3–5.8)	1.5 (1.2–1.9)	0.5 (0.4–0.7)	1.2 (0.8–1.7)	1.5 (1.0–2.2)
Adjusted OR (Model 1)[2] (95% CI)	1.6 (0.6–3.9)	1.3 (0.9–1.7)	0.7 (0.5–0.9)	1.2 (0.8–1.8)	1.3 (0.8–2.2)
Adjusted OR (Model 2)[3] (95% CI)	1.3 (0.5–3.2)	1.2 (0.9–1.6)	0.7 (0.5–0.9)	1.2 (0.8–1.8)	1.2 (0.7–2.0)
Women					
BMI, kg/m^2	<19.0	19.0–24.9	25.0–29.9	30.0–34.9	≥35.0
n	1,546	13,825	6,135	2,146	748
Food sufficient, %	6.3	57.0	25.0	8.7	3.0
OR	1.0	1.0	1.0	1.0	1.0
Food insufficient, %	7.8	50.7	27.1	10.0	4.4
Unadjusted OR (95% CI)	1.3 (0.9–1.9)	0.8 (0.6–0.9)	1.1 (0.9–1.4)	1.2 (0.9–1.5)	1.5 (1.1–2.1)
Adjusted OR (Model 1)[2] (95% CI)	1.0 (0.7–1.5)	0.9 (0.7–1.1)	1.2 (0.9–1.5)	1.0 (0.8–1.4)	1.0 (0.6–1.6)
Adjusted OR (Model 2)[3] (95% CI)	1.0 (0.7–1.6)	1.0 (0.8–1.2)	1.2 (0.9–1.5)	0.9 (0.7–1.2)	0.8 (0.5–1.4)

[1] Abbreviations used: OR, odds ratio; CI, confidence interval.
[2] Adjusted for age group, education level, and income adequacy.
[3] Adjusted for age group, education level, income adequacy and functional health.

with poorer health status across multiple dimensions of health—physical, mental and social. These findings are consistent with the results of a recent U.S. study of elderly disabled women in which food insufficiency (assessed in terms of financial difficulty acquiring food) was significantly associated with depression among all women, poorer social health and physical performance among white women and a greater number of medical conditions among minority women (11). In addition to associations among self-reported measures of health, the authors also determined that iron deficiency anemia was 2.9 times more likely among women reporting food insufficiency (11). A study of single women welfare recipients in the United States found significant associations between food insufficiency (assessed in terms of quantitative food deprivation) and poor or fair self-rated health, physical limitations and major depression (12). Food sufficiency has also been shown to be associated with poor general and physical health, and with negative psychosocial outcomes in American children (13,14,66), and with depressive disorders and suicidal behaviors in American teens (15). Several other studies have documented relationships between indicators of food insecurity and poor or fair self-rated health (7,8,10,67) and chronic health conditions (7,8). Severity of household food insecurity was also found to relate to poorer self-rated health, activity restrictions and chronic conditions among a small Canadian sample of low income women (68).

The cross-sectional nature of these findings makes it impossible to draw causal inferences. Although it might be argued that household food insufficiency predisposes individuals to poor health, the reverse could also be true. The fact that we have observed associations across such a broad array of physical, mental and social health indicators suggests that the interrelationship between household food insufficiency and health is unlikely to be condition-specific. Longitudinal data, including a more comprehensive measure of household food insecurity, are required to ascertain the true nature of the associations reported here. It should also be noted that our analyses relied entirely on self-reported measures; research examining food insecurity in relation to objective measures of health is required to confirm our findings.

The absence of significant positive associations between food insufficiency and measures of underweight or overweight after adjusting for potentially confounding variables adds to the controversy in this area. After adjusting for potentially confounding variables, Alaimo et al. (43) found an increased prevalence of overweight and food insufficiency occurring in older non-Hispanic Caucasian children in the United States, but not in younger non-Hispanic Caucasian children, non-Hispanic African-American children or Mexican-American children. However, four recent analyses of population-level survey data have revealed measures of food insecurity to be significantly associated with overweight and obesity (8,24, 69,70). The discrepancy in results may be due to methodological differences between studies, including differences in the study population, sample size, food security measurement, definition of BMI cut-points denoting overweight and obesity, and control of potentially confounding variables.

The observation that individuals in food-insufficient households were more likely to report heart disease, diabetes, high blood pressure and food allergies is of concern given that each condition is likely to be managed at least in part by dietary modifications. If people are finding it difficult to always get "enough to eat," then tailoring their food selection patterns to specific dietary regimens is likely problematic too, particularly given that some special diets appear to be associated with increased food costs (71). Our concern about individuals' abilities to manage chronic health conditions in the context of household food insecurity is supported by research such as that indicating that hypoglycemia was linked to hunger and food insecurity among a sample of diabetic patients in one U.S. urban county hospital (72).

In conclusion, the results of this secondary analysis highlight the pervasive vulnerability of individuals living in food-insufficient households. In addition to food problems, food-insufficient households in Canada struggle with a broad spectrum of health problems. More research is required to fully understand why this relationship exists, but our findings indicate the importance of broadening the discussion of responses to food insecurity beyond short-term food-based intervention.

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APPENDIX 1: CATEGORY DEFINITIONS FOR INCOME ADEQUACY VARIABLE

Income adequacy	Category definition
Lowest income	<$10,000 if 1–4 persons
	<$15,000 if 5+ persons
Lower middle income	$10,000–$14,999 if 1–2 persons
	$10,000–$19,000 if 3–4 persons
	$15,000–$29,999 if 5+ persons
Middle income	$15,000–$29,999 if 1–2 persons
	$20,000–$39,999 if 3–4 persons
	$30,000–$59,999 if 5+ persons
Upper middle income	$30,000–$59,999 if 1–2 persons
	$40,000–$79,999 if 3–4 persons
	$60,000–$79,999 if 5+ persons
Highest income	≥$60,000 if 1–2 persons
	≥$80,000 if 3+ persons

APPENDIX 2: DESCRIPTION OF VARIABLES USED TO INDICATE GENERAL, PHYSICAL, MENTAL AND SOCIAL HEALTH

General health measure

Poor/fair self-rated health. Respondents of all ages were asked to rate their own health according to one of five categories: poor, fair, good, very good and excellent. A dichotomous variable was constructed to denote those who did and did not rate their own health as poor/fair.

Poor functional health. This variable is derived from the Health Utility Index (HUI) (27), a generic measure of health status administered to respondents ≥4 y old in the NPHS. The HUI provides a description of an individual's overall functional health based on eight attributes: vision, hearing, speech, ambulation, dexterity, emotion, cognition, and pain, with 5 or 6 levels per attribute. A score between 0 and 1 is assigned for all possible combinations of levels of these eight self-reported health attributes. In this analysis, those with a HUI score ≥0.83 were classified as not having poor functional health, whereas those with a HUI score <0.83 were classified as having poor functional health. This cut-point was based on the clinical judgment and consensus of others (28). For example, an individual who requires mechanical support for walking (e.g., cane), but does not have any pain or other limitations would obtain a score of 0.830 and would not be classified as having poor functional health here; an individual with difficulty walking and pain that restricts at least some activities would obtain a score of 0.814 and would be classified as having poor functional health (28).

Physical health measures

Restricted activity. This variable categorizes respondents of all ages as having or not having any long-term disabilities or handicaps and/or any long-term physical or mental condition or health problem that limits the kind or amount of activity that he/she can do at home/school/work/other activities.

Multiple chronic conditions. Respondents ≥12 y old were asked if they had chronic conditions that had lasted or were expected to last ≥6 mo and that had been diagnosed by a health professional. The conditions listed were: food allergies, other allergies, asthma, arthritis or rheumatism, back problems, high blood pressure, migraine headaches, chronic bronchitis or emphysema, sinusitis, diabetes, epilepsy, heart disease, cancer, stomach or intestinal ulcers, effects of stroke, urinary incontinence, bowel disorders, Alzheimer's disease or other dementia, cataracts, glaucoma, thyroid condition and any other long-term condition. Respondents were considered to have multiple chronic conditions if they reported to have at least three (8).

Mental health measures

Having major depression. This variable is derived from the University of Michigan-Composite International Diagnostic Interview-Short Form (UM-CIDI-SF), a brief questionnaire used to predict the occurrence of major depression (29,30). The UM-CIDI-SF, administered to NPHS respondents ≥12 y old, predicts caseness based on two central features of depression: feeling sad, blue, or depressed; losing interest in most things (30). If respondents reported experiencing either feature at least most of the day, almost every day, for a period of 2 wk in the previous 12 mo, they were then asked to answer "yes" or "no" to a series of symptoms (30). According to developers' validation data, there is a 90% probability of major depression (in the preceding 12 mo) in subjects reporting 5 or more depressive symptoms in response to UM-CIDI-SF questions (31). As in other studies (29,32–34), a cut-point of 5 has been used here to categorize respondents as having or not having major depression.

Having distress. This variable is derived from the Distress Index, which is based on six questions: "During the past month, how often did you feel: so sad that nothing could cheer you up? nervous? restless or fidgety? hopeless? worthless? that everything was an effort?" The response options are: all of the time, most of the time, some of the time, a little of the time and none of the time; they were given weights of 5, 4, 3, 2 and 1, respectively (8). The index was the sum of the assigned weights from the six questions (8). A higher score indicates greater distress. Because >85% of those who responded to questions on the Distress Index scored under 7 out of 24, a cut-point of 7 was used here to categorize respondents as having or not having distress. This cut-point has been used by others (8). In the NPHS, only those respondents ≥12 y old were assessed by the Distress Index.

Social health

Poor social support. This variable is derived from the Social Support Index, a four-item index that measures perceived social support. Respondents ≥12 y old were prompted to answer "yes" or "no" to whether they had someone who they could confide in, count on, could give them advice, and who makes them feel loved. A score of 1 was given for an answer of "yes" to each question, and a score of 0 for an answer of "no," with a maximum possible score of 4. Because >85% of those who responded to questions on the Social Support Index scored 4 out of 4, a cut-point of 4 was used here to categorize respondents as having or not having poor social support.