Association between household food insecurity and annual health care costs

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CMAJ Podcasts: author interview at soundcloud.com/cmajpodcasts/150234-res

See also www.cmaj.ca/lookup/doi/10.1503/cmaj.150644

Abstract

Background: Household food insecurity, a measure of income-related problems of food access, is growing in Canada and is tightly linked to poorer health status. We examined the association between household food insecurity status and annual health care costs.

Methods: We obtained data for 67 033 people aged 18–64 years in Ontario who participated in the Canadian Community Health Survey in 2005, 2007/08 or 2009/10 to assess their household food insecurity status in the 12 months before the survey interview. We linked these data with administrative health care data to determine individuals' direct health care costs during the same 12-month period.

Results: Total health care costs and mean costs for inpatient hospital care, emergency department visits, physician services, same-day surgeries, home care services and prescription drugs covered by the Ontario Drug Benefit Program rose systematically with increasing severity of household food insecurity. Compared with total annual health care costs in food-secure households, adjusted annual costs were 16% ($235) higher in households with marginal food insecurity (95% confidence interval [CI] 10%–23% [$141–$334]), 32% ($455) higher in households with moderate food insecurity (95% CI 25%–39% [$361–$553]) and 76% ($1092) higher in households with severe food insecurity (95% CI 65%–88% [$934–$1260]). When costs of prescription drugs covered by the Ontario Drug Benefit Program were included, the adjusted annual costs were 23% higher in households with marginal food insecurity (95% CI 16%–31%), 49% higher in those with moderate food insecurity (95% CI 41%–57%) and 121% higher in those with severe food insecurity (95% CI 107%–136%).

Interpretation: Household food insecurity was a robust predictor of health care utilization and costs incurred by working-age adults, independent of other social determinants of health. Policy interventions at the provincial or federal level designed to reduce household food insecurity could offset considerable public expenditures in health care.

Competing interests: None declared.

This article has been peer reviewed.

Accepted: June 26, 2015
Online: Aug. 10, 2015

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***CMAJ* 2015. DOI:10.1503/cmaj.150234**

Income-related problems of food access, variously termed "food poverty" or "food insecurity," are increasingly recognized as serious social and public health problems in many affluent nations. In 2012, 12.6% of Canadian households were affected by some degree of food insecurity; this is the highest rate observed since national monitoring began in 2007.[1]

Problems of food insecurity are intertwined with household resource constraints, but food insecurity is nonetheless a strong predictor of poorer physical and mental health, independent of other well-established social determinants of health. Among children, food insecurity has been linked to poorer health status[2–6] and the development of a variety of chronic health conditions, including asthma and depression.[7,8] Among adults, it has been associated with multiple indicators of chronic disease and poorer health.[9–11] The association between food insecurity and health appears to be a gradient, with adults in more severely food-insecure households more likely to report chronic health conditions[12–14] and to receive diagnoses of multiple conditions.[11] Household food insecurity has been shown to diminish adults' functional health,[15] pose barriers to self-care for those with chronic conditions,[16–18] increase the probability that they will become high-cost users of health care[19] and heighten the risk of negative disease outcomes.[17,20]

Our understanding of the association between household food insecurity and health is largely

based on analyses of population-based surveys with self-reported measures of health. Few studies have drawn on clinical measures of health status[10,20–23] or health services data,[16,19,24,25] and there has been no examination of the total burden of ill health associated with food insecurity or the implications for health care costs.

In Canada, where the provision of health care is universal and food insecurity appears tightly linked to health status, understanding the health consequences and related health care costs is critical for charting program and policy directions to address household food insecurity. Using linked survey and administrative health care data from the province of Ontario, we examined the association between adults' household food security status over a 12-month period and their direct health care costs during this period, from the perspective of the payer, the Ontario Ministry of Health and Long-term Care.

Methods

Data sources

Data were drawn from Canadian Community Health Survey conducted in 2005, 2007/08 and 2009/10.[26–29] This survey is a repeated cross-sectional survey designed to be representative of 98% of the Canadian population aged 12 and over; individuals living on First Nation reserves, those in institutions and personnel in the Canadian Armed forces are excluded. Once a household is identified as part of the sample, one household member is selected based on various sampling probabilities related to age and household composition.

We linked Canadian Community Health Survey data for Ontario to de-identified administrative health care data housed at the Institute for Clinical Evaluative Sciences. The administrative databases included the Canadian Institute for Health Information Discharge Abstract Database and Same Day Surgery Database, the Ontario Mental Health Reporting System, the National Ambulatory Care Reporting System, the Continuing Care Reporting System, Ontario Health Insurance Plan (OHIP) claims database, the Ontario Drug Benefit claims database, the Home Care Database, the National Rehabilitation Reporting System, the Continuing Care Reporting System and the Assisted Devices Program Database. These datasets were linked with the use of unique encoded identifiers and analyzed at the Institute for Clinical Evaluative Sciences.

Study population

Our initial linked sample comprised 67 947 participants in the Canadian Community Health Survey who were aged 18–64 years, were living in Ontario and had a valid Ontario health insurance number during the 12 months before the survey interview. We excluded 580 individuals who had missing data on food security status and 334 with missing data on sociodemographic variables; this left 67 033 individuals in the final analytic sample.

To minimize loss of sample due to missing data on income (a problem affecting 21% of respondents), we derived neighbourhood-level income quintiles by linking 2006 census data to the patients' residential postal code data. Statistics Canada has adjusted income for household size and community size such that each community would be expected to have 20% of its population in each income quintile. This ecological proxy methodology has been found to estimate household income quintiles reliably.[30]

Measures

Household food security status and sociodemographic characteristics were derived from the Canadian Community Health Survey. We assessed household food insecurity during the 12 months before the survey using an 18-item scale (Appendix 1, available at www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.150234/-/DC1) also used to monitor food insecurity in the United States.[31,32] Health Canada's coding method was applied to define moderate and severe food insecurity.[32] Survey participants with no affirmative responses were considered "food secure." Those with one affirmative response were considered "marginally food insecure," given evidence of heightened vulnerability with even a single affirmative response on this scale.[11,12,33–35] (The coding applied to determine household food security status is described in Appendix 2, available at www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.150234/-/DC1).

To calculate individual-level health care costs for the 12-month period before the survey interview, we linked utilization data from administrative health care databases with individual provider and corporate cost information collected by the Ontario Ministry of Health and Long-Term Care.[36] The total cost of health care included costs for acute and psychiatric inpatient care, emergency department visits, physician services and outpatient care, same-day surgeries, home care, claims for outpatient prescription drugs covered under the Ontario Drug Benefit Program and other (e.g., rehabilitation, complex continuing care, long-term care, assisted devices). We adjusted all costs to 2012 Canadian dollars.[36]

Statistical analysis

We describe sample characteristics using means and proportions. Linear trend tests were performed to examine the association between each covariate

and food security status; analysis of variance was used for continuous variables and the Cochran–Armitage test for categorical variables. Linear trend tests were conducted to analyze the association between different types of health care costs and household food insecurity status.

Two-part regression models[37] were used to determine the association between household food insecurity and the costs associated with each participant's health care utilization. First, we modelled the odds of incurring any expenditure using logistic regression analysis. We then modelled the level of expenditure, conditional on incurring any expenditure, using ordinary least-squares regression with a logged dependent variable (based on the Park test, which showed that the residuals were normally distributed and homoscedastic).[38] We adjusted the models for age, sex and sociodemographic characteristics identified through prior research as significant predictors of household food insecurity[11] and health care costs. These variables included education level, neighbourhood income quintile, number of children and adults living in the household, and home ownership. We used the Duan smearing estimator to retransform the ordinary least-squares regression estimates to the original units in dollars.[39]

We ran the 2-part regression models both with and without the inclusion of the Ontario Drug Benefit claims in total health care costs. We did this because, unlike the other cost categories considered, this public drug program is available only to select population subgroups.[40] Among adults under 65 years of age, eligibility for drug benefits is linked to eligibility for social assistance, which in turn is known to be associated with high risk of food insecurity, specifically more severe food insecurity.[1] Thus, Ontario Drug Benefit costs are potential confounders of food insecurity that would increase the probability of finding significant differences by food security status.

Table 1: Characteristics of 67 033 people aged 16–64 who participated in the Canadian Community Health Survey in 2005, 2007/08 or 2009/10, by household food security status

	Food security status; no. (%) of participants*					
			Food insecure			
Characteristic	Total n = 67 033	Food secure n = 58 875	Marginal n = 2 593	Moderate n = 3 479	Severe n = 2 086	p value†
Age at interview, yr, mean ± SD	42.2 ± 13.5	42.5 ± 13.5	38.2 ± 12.9	40 ± 13.1	41.5 ± 12.6	0.2
Sex						
Female	36 020 (53.7)	31 082 (52.8)	1 501 (57.9)	2 126 (61.1)	1 311 (62.8)	< 0.001
Male	31 014 (46.3)	27 794 (47.2)	1 092 (42.1)	1 253 (38.9)	775 (37.2)	< 0.001
Education level						
Less than secondary school graduation	7 617 (11.4)	5 903 (10.0)	423 (16.3)	759 (21.8)	532 (25.5)	< 0.001
Secondary school graduation	12 839 (19.2)	11 124 (18.9)	574 (22.1)	744 (21.4)	397 (19.0)	0.001
Some postsecondary school	5 636 (8.4)	4 765 (8.1)	290 (11.2)	354 (10.2)	227 (10.9)	< 0.001
Postsecondary school graduation	40 941 (61.1)	37 083 (63.0)	1 306 (50.4)	1 622 (46.6)	930 (44.6)	< 0.001
Homeowner	51 768 (77.2)	48 246 (81.9)	1 482 (57.2)	1 455 (41.8)	585 (2.1)	< 0.001
No. of children < 18 yr in household, mean ± SD	0.6 ± 0.9	0.5 ± 0.9	0.8 ± 1.1	0.7 ± 1.1	0.5 ± 0.9	< 0.001
No. of adults in household, mean ± SD	2.1 ± 0.9	2.1 ± 0.9	2 ± 0.9	1.8 ± 0.9	1.5 ± 0.8	< 0.001
Neighbourhood income quintile						
1 (lowest)	13 202 (19.7)	10 353 (17.6)	741 (28.6)	1 216 (35.0)	892 (42.8)	< 0.001
2	13 503 (20.1)	11 636 (19.8)	585 (22.6)	825 (23.7)	457 (21.9)	< 0.001
3	13 702 (20.4)	12 205 (20.7)	537 (20.7)	623 (17.9)	337 (16.2)	< 0.001
4	13 492 (20.1)	12 394 (21.1)	405 (15.6)	467 (13.4)	226 (10.8)	< 0.001
5 (highest)	13 134 (19.6)	12 287 (20.9)	325 (12.5)	348 (10.0)	174 (8.3)	< 0.001

Note: SD = standard deviation
*Unless stated otherwise.
†Tests for linear trend (analysis of variance for continuous variables and Cochran–Armitage test for categorical variables) across all 4 levels of food security status.

We conducted a sensitivity analysis to examine the impact of using neighbourhood-level income quintiles rather than reported household incomes in the 2-part regression models. Models that included only participants who reported household income were run with income included as a continuous variable.

All analyses were conducted with the use of SAS statistical software, version 9.2. The significance level was set at $p < 0.05$.

Results

The mean age of participants in the study sample was 42.2 (standard deviation ± 13.5) years, and 53.7% were female (Table 1). With respect to food insecurity status, 3.9% lived in marginally, 5.2% in moderately and 3.1% in severely food insecure households. When stratified by household food insecurity status, the participants differed significantly in age, education level, home ownership, household composition and household income (Table 1).

Mean individual-level health care costs rose systematically with increasing severity of household food insecurity (Table 2). This gradient was statistically significant for costs arising from every type of health care services except "other" costs (i.e., rehabilitation, complex continuing care, long-term care and assisted devices).

Overall, 89.2% (59 817) of the 67 033 participants used heath care (excluding outpatient prescription drugs covered under the Ontario Drug Benefit Program) in the 12-month period before their survey interview (Table 3). After adjusting for sociodemographic variables, we found that individuals who were in severely food insecure households had 1.71 times the odds of using health care services (95% confidence interval [CI] 1.44–2.04) than those in food secure households; individuals in moderately food insecure households had 1.33 times the odds of using health care (95% CI 1.18–1.50). Participants in marginally food insecure households did not have significantly higher odds of using health care (odds ratio 1.13, 95% CI 0.99–1.29) than those in food secure households.

Among health care users, total health care costs increased significantly with the level of food insecurity (Table 3). Compared with total annual costs in food-secure households, adjusted annual costs were, on average, 16% ($235) higher in households with marginal food insecurity (95% CI 10%–23% [$141–$334]), 32% ($455) higher in households with moderate food insecurity (95% CI 25%–39% [$361–$553]) and 76% ($1092) higher in households with severe food insecurity (95% CI 65%–88% [$934–$1260]).

When we repeated these analyses to include prescription drug costs, we found that all 3 levels of food insecurity were associated with significantly increased odds of using health care services (Appendix 3, Table A, available at www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.150234/-/DC1) and even greater increases in total health care costs compared with individuals in food-secure households. Adjusted annual health care costs were 23% higher in households with marginal food insecurity (95% CI 16%–31%), 49% higher in those with moderate food insecurity (95% CI 41%–57%) and 121% higher in households with severe food insecurity (95% CI 107%–136%).

Table 2: Mean individual-level health care costs for the 12-month period before the survey interview, by household food security status

	Food security status; adjusted cost,* $, mean ± SD					
			Food insecure			
Health care service	Total n = 59 869	Food secure n = 52 440	Marginal n = 2321	Moderate n = 3172	Severe n = 1936	p value†
Inpatient care	500 ± 3927	461 ± 3897	604 ± 3366	730 ± 4251	1063 ± 4673	< 0.001
Emergency department visits	116 ± 355	105 ± 321	153 ± 381	181 ± 436	282 ± 761	< 0.001
Physician services	718 ± 1406	688 ± 1365	765 ± 1296	905 ± 1530	1165 ± 2144	< 0.001
Same-day surgery	105 ± 499	102 ± 489	118 ± 537	118 ± 570	139 ± 606	0.003
Home care	75 ± 1066	65 ± 1061	147 ± 1287	131 ± 939	175 ± 1101	< 0.001
Ontario Drug Benefit claims	160 ± 1296	99 ± 1129	305 ± 1393	587 ± 2411	943 ± 2120	< 0.001
Other‡	93 ± 2312	88 ± 2290	70 ± 1483	155 ± 2642	164 ± 3014	0.09
Total	1768 ± 6589	1608 ± 6414	2161 ± 6235	2806 ± 7923	3930 ± 8455	< 0.001

Note: SD = standard deviation.
*Adjusted to 2012 Canadian dollars.
†Test for linear trend (analysis of variance) across all 4 levels of food security status.
‡Rehabilitation, complex continuing care, long-term care and assisted devices.

When these analyses were repeated to include only participants who reported household income, with household income used in the models instead of neighbourhood income quintile, the associations between food insecurity status and health care utilization and costs were slightly stronger than in the main analyses (Appendix 3, Table B).

Interpretation

Our study showed that household food insecurity status was a robust predictor of health care utilization and costs incurred by working-age adults in Ontario, independent of other well-established social determinants of health. The observed effect of household food insecurity on health care expenditures was free of selection issues because our study occurred in the context of a universal health care system. Even when we excluded costs for prescription drugs covered by the Ontario Drug Benefits plan, because the plan is available only to a subset of the population, we still found a highly significant effect of food insecurity on health care spending.

To date, no provincial or federal intervention has been introduced with the explicit goal of reduc-

Table 3: Results of 2-part regression model predicting health care utilization and total health care costs over a 12-month period

	Odds of health care expenditure* n = 67 033		Total health care costs per person† n = 59 817	
Variable	Unadjusted OR (95% CI)	Adjusted‡ OR (95% CI)	Unadjusted mean, $ (95% CI)	Adjusted‡ mean, $ (95% CI)
Food insecurity status				
Food secure	1.00 (ref)	1.00 (ref)	1516 (1498–1534)	1438 (1421–1455)
Marginally food insecure	1.03 (0.90–1.17)	1.13 (0.99–1.29)	1748 (1647–1849)	1673 (1579–1767)
Moderately food insecure	1.21 (1.08–1.36)	1.33 (1.18–1.50)	2143 (2037–2249)	1892 (1800–1985)
Severely food insecure	1.54 (1.30–1.81)	1.71 (1.44–2.04)	3078 (2883–3273)	2529 (2370–2688)
Age§	1.02 (1.02–1.02)	1.02 (1.02–1.02)	1542 (1525–1559)	1494 (1478–1511)
Sex				
Male	1.00 (ref)	1.00 (ref)	1216 (1196–1237)	1128 (1109–1146)
Female	3.00 (2.84–3.16)	2.98 (2.83–3.15)	2011 (1981–2041)	1855 (1828–1882)
Education level				
Less than secondary school graduation	0.96 (0.88–1.03)	1.02 (0.94–1.11)	1989 (1922–2057)	1678 (1622–1734)
Secondary school graduation	0.87 (0.81– 0.92)	0.94 (0.88–1.01)	1521 (1481–1561)	1460 (1423–1497)
Some postsecondary school	0.90 (0.83–0.98)	1.08 (0.98–1.18)	1382 (1327–1436)	1446 (1391–1502)
Postsecondary school graduation	1.00 (ref)	1.00 (ref)	1585 (1562–1609)	1480 (1459–1500)
Homeowner				
Yes	1.00 (ref)	1.00 (ref)	1523 (1504–1543)	1447 (1428–1465)
No	0.74 (0.70–0.78)	0.77 (0.72–0.82)	1869 (1824–1915)	1673 (1630–1717)
No. of children < 18 yr in household	1.08 (1.05–1.10)	1.10 (1.07–1.13)	1600 (1581–1618)	1494 (1478–1511)
No. of adults in household	0.96 (0.93–0.98)	1.05 (1.0–1.08)	1586 (1568–1604)	1494 (1478–1511)
Neighbourhood income quintile				
1 (lowest)	1.00 (ref)	1.00 (ref)	1759 (1714–1805)	1526 (1487–1566)
2	1.05 (0.97–1.13)	1.01 (0.93–1.09)	1613 (1572–1654)	1485 (1449–1522)
3	1.07 (0.99–1.15)	1.00 (0.93–1.09)	1558 (1519–1598)	1473 (1438–1509)
4	1.18 (1.09–1.27)	1.09 (1.01–1.18)	1553 (1513–1592)	1495 (1459–1532)
5 (highest)	1.20 (1.11–1.30)	1.11 (1.03–1.21)	1553 (1513–1592)	1493 (1456–1530)

Note: CI = confidence interval, OR = odds ratio, ref = reference group.
*Part 1: logistic regression analysis was used to estimate the odds of incurring any v. no health care cost over the 12-month period, excluding Ontario Drug Benefit costs.
†Part 2: ordinary least-squares regression analysis was used to determine the total health care costs per person associated with each variable, conditional on incurring any cost during the same 12-month period. Costs were adjusted to 2012 Canadian dollars. Model estimates have been retransformed to provide the predicted cost at the mean value for each variable.
‡Adjusted for all other variables in the table.
§Odds ratios are per year increase in age.

ing household food insecurity, but our study findings suggest that such intervention would offset considerable public expenditures on health care. Some have argued that health care providers should screen patients for food insecurity and then assist them to access additional supports, such as the publicly funded food assistance programs available in the US.[10,41] However, in Canada, there are no publicly funded programs designed to prevent or alleviate food insecurity and the existing ad hoc community-based food charities and other food programs lack the capacity to alter household food insecurity.[42–45] Thus, health care providers have little chance of altering patients' circumstances through referrals. A more upstream approach is required, with policy interventions aimed at reducing the prevalence and severity of food insecurity. Relatively modest increments in income have been found to lessen food insecurity among low-income families,[46–48] and the lower rate of food insecurity among Canadian seniors has been attributed to the guaranteed annual incomes provided to them.[49,50]

Our findings are consistent with reports of poorer health and increased probability of diagnoses of chronic disease,[10,11,13] poorer disease management[16–18] and increased health care costs[5] associated with household food insecurity, with the evidence of a graded relation between severity of food insecurity and adults' health status.[11,14,35] The extreme levels of material deprivation associated with household food insecurity, and severe food insecurity in particular, have been associated with extensive dietary compromise,[51–53] higher levels of stress[35,54] and compromises across a broad spectrum of basic needs,[33,54,55] all of which diminish individuals' abilities to manage health problems and potentially increase the need for health care. Yet, empirical examinations of the resultant health care costs have been limited by the paucity of datasets, including both a validated measure of household food insecurity and objective measures of health care utilization.[15]

Limitations

Our study was well designed to capture health care costs borne by the provincial government, but we did not have data on out-of-pocket expenditures or on health care costs covered by private insurance plans or employee benefit programs. Prior research suggests that out-of-pocket expenditures on health care are inversely associated with household food insecurity,[55–57] because such expenditures are often foregone in the context of competing financial demands for scarce resources. In addition, although some individuals in households reliant on employment incomes might have received supplementary drug coverage through their employer, the employment conditions associated with food insecurity in Canada[58] suggest that many would not have had such benefits. Had we been able to construct a comprehensive account of individuals' health care costs, we hypothesize that health care expenditures would have risen disproportionately among food-secure adults owing to the inclusion of prescription drug benefits. As a consequence, observed differences associated with household food insecurity status would have been attenuated, but this would not have affected the sharp gradient in public expenditures on health care related to food insecurity status.

The strong gradient in health care costs associated with increasing severity of household food insecurity suggests a causal relation between food insecurity and health care utilization, but more research is needed to confirm the direction of the effects, recognizing the possibility of a bidirectional association between adults' health and their household food security status.[59–61] Further research is also needed to elucidate the pathway(s) through which household food insecurity affects adults' health and use of health care, distinguishing costs arising from poor disease management and complications of existing conditions from costs related to new health conditions. In tandem with this work, the duration of individuals' exposures to food insecurity needs to be tracked beyond the 12-month window captured in the Canadian Community Health Survey.

Our study used data from 2005–2010, but the prevalence of household food insecurity in Ontario has not changed significantly in recent years.[1] Furthermore, Ontario has one of the lowest rates of food insecurity in Canada, at 11.7% in 2012.[1] Thus, food insecurity is likely taking an even greater toll on provincial and territorial health care budgets elsewhere in Canada.

Conclusion

Our study showed that household food insecurity was a robust predictor of health care utilization and costs incurred by working-age adults, independent of other social determinants of health. Policy interventions at the provincial or federal level designed to reduce household food insecurity could offset considerable public expenditures in health care and improve overall health.

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Contributors: Valerie Tarasuk conceived of the study and oversaw all aspects of it. Joyce Cheng conducted the statistical analyses, with guidance from Claire de Oliveira, Craig Gundersen and Paul Kurdyak. Valerie Tarasuk, Joyce Cheng, Claire de Oliveira, Naomi Dachner and Craig Gundersen were responsible for the interpretation of the analytic results. Paul Kurdyak facilitated access to the data. Valerie Tarasuk, Joyce Cheng and Naomi Dachner drafted the manuscript. All of the authors contributed to the critical revision of the manuscript, approved the final version to be published and agreed to act as guarantors of the work.

Funding: This study was funded by a Programmatic Grant in Health and Health Equity from the Canadian Institutes of Health Research (CIHR) (grant no. FRN 115208). The analysis was also supported by the Institute for Clinical Evaluative Sciences (ICES), which is funded by an annual grant from the Ontario Ministry of Health and Long-Term Care (MOHLTC). The opinions, results and conclusions reported in this paper are those of the authors and are independent from the funding sources. No endorsement by the CIHR, ICES or the MOHLTC is intended or should be inferred. The study sponsors had no role in the design of the study, the collection, analysis or interpretation of data, the writing of the report or the decision to submit the article for publication.