Pain has grown more prevalent in high-income countries, including Canada and the United States, where 1 in 5 people report having chronic pain.\(^1,2\) Lack of pain clinics and long wait times have forced many to self-medicate — sometimes with illicit drugs — and to seek care at an emergency department.\(^3\) Abdominal and pelvic pain, pain in the throat and chest, and dorsalgia are among the most common causes of emergency department visits in Canada, jointly accounting for one-tenth of all visits.\(^4\) Pain may reduce quality of life and trigger or exacerbate substance abuse, anxiety and depression,\(^5,6\) precipitating suicide in extreme cases.\(^7\) Service delays and undertreatment at emergency departments are believed to contribute to risky self-medication by patients with pain.\(^8\) In the context of a health care system, poorly managed pain has been associated with increased health care utilization and costs.\(^9\)

Food insecurity — inadequate or insecure access to food because of financial constraints — is a serious problem in Canada.\(^10\) The ongoing COVID-19 pandemic further aggravated the issue.\(^11,12\) As a well-established social determinant of health, food insecurity has been associated with multiple negative health outcomes, including mental disorders, substance use and suicide.\(^13-18\)

Population research connecting food insecurity and pain is rare. As a notable exception, food insecurity has been associated with self-reported chronic pain among Canadian adults and adolescents in a graded fashion.\(^19\) Two other cross-sectional studies have associated food insecurity with self-reported migraine among Canadians and young adults in the US.\(^20,21\) A higher prevalence of pain has been documented among lower income and less educated populations,\(^22-24\) but those indicators do not necessarily capture food insecurity and its associated health hazards.

### Abstract

**Background:** As the leading cause of emergency department visits in Canada, pain disproportionately affects socioeconomically disadvantaged populations. We examine the association between household food insecurity and individuals’ pain-driven emergency department visits.

**Methods:** We designed a cross-sectional study linking the Canadian Community Health Survey 2005–2017 to the National Ambulatory Care Reporting System 2003–2017. Food insecurity was measured using a validated questionnaire. We excluded individuals with missing food insecurity status, individuals younger than 12 years and jurisdiction-years with partial emergency department records. We assessed emergency department visits driven by pain at different sites (migraine, other headaches, chest–throat pain, abdomen–pelvis pain, dorsalgia, joint pain, limb pain, other pain) and their characteristics (frequency, cause, acuity and time of emergency department visit) in Ontario and Alberta. We adjusted for sociodemographic characteristics, lifestyle and prior non–pain-driven emergency department visits in the models.

**Results:** The sample contained 212,300 individuals aged 12 years and older. Compared with food-secure individuals, marginally, moderately and severely food-insecure people had 1.42 (95% confidence interval [CI] 1.20–1.68), 1.64 (95% CI 1.37–1.96) and 1.99 (95% CI 1.61–2.46) times higher adjusted incidence rates of pain-driven emergency department visits, respectively. The association was similar across sexes and significant among adults but not adolescents. Food insecurity was further associated with site-specific pain, with severely food-insecure individuals having significantly higher pain incidence than food-secure individuals. Severe food insecurity predicted more frequent, multicause, high-acuity and after-hours emergency department visits.

**Interpretation:** Household food insecurity status is significantly associated with pain-driven emergency department visits in the Canadian population. Policies targeting food insecurity may reduce pain and emergency department utilization.

---

### Pain-driven emergency department visits and food insecurity: a cross-sectional study linking Canadian survey and health administrative data

Fei Men PhD, Marcelo L. Urquia PhD, Valerie Tarasuk PhD

---

**Competing interests:** None declared.

This article has been peer reviewed.

**Correspondence to:** Fei Men, fmen@ua.edu

**CMAJ Open 2022 January 11. DOI:10.9778/cmajo.20210056**
Food-insecure people may be more susceptible to pain than food-secure individuals because of their higher likelihood of having chronic diseases,14-17,25-28 stress9,10 and physically demanding jobs.22,31 Moreover, pain may be less manageable for food-insecure patients and more likely to require emergency department intervention because of cost-related nonadherence to pain-relieving prescriptions and therapy,32-34 suboptimal dietary intakes,35 hampered access to physicians owing to inflexible work schedules and residence location,31,36-38 inadequate social support22,29 and discrimination.39 Two studies reported higher emergency department use among food-insecure adults in Ontario, Canada,16,40 and studies have found that food insecurity is associated with higher emergency department use in the US.31-41 None of these studies has examined the role of pain in emergency department visits.

Food-insecure people may use emergency departments more than their food-secure counterparts for reasons related to pain; however, evidence to date has either focused on self-reported pain or all-cause emergency department visits.19-21,40-43 Understanding inequity in pain-driven emergency department use is necessary for effective pain management and sustainable health care. We linked a Canadian population survey to emergency department records to examine the association between the severity of household food insecurity and individual pain-driven emergency department visits.

Methods

Study design

We conducted a retrospective analysis of cross-sectional survey data linked to health administrative data. The study was reported according to the Reporting of Studies Conducted Using Observational Routinely-collected Data (RECORD).44

Data and sample

The Canadian Community Health Survey (CCHS) is an annual cross-sectional survey administered to roughly 65 000 households in Canada, with response rates of 60%-80%.45-47 One member aged 12 years or older is randomly selected per household to answer the survey. Indigenous people living on reserves, members of the Canadian Armed Forces, people living in institutions, children in foster care and people living in northern Quebec are excluded. The responses generalize to 98% of the noninstitutionalized population aged 12 years and older in the country. Questions on food insecurity have been formally incorporated in the survey since 2005, though certain provinces and territories chose not to include those questions when given the option.

The National Ambulatory Care Reporting System (NACRS) contains roughly 64% of administrative records on emergency department visits in Canada.48 The NACRS has collected records for all emergency department visits in Ontario since 2002, Alberta since April 2010, and Yukon since 2015. Records are partial for other jurisdiction-years. The NACRS provides case-level information on timing, type, severity, cause and disposition of each emergency department visit. Each visit is assigned 1 main cause — the problem deemed the clinically significant reason for the visit requiring evaluation or treatment or management — and up to 9 joint causes, all coded in the International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Canada (ICD-10-CA).

We limited our sample to CCHS respondents interviewed from 2005 to 2017 in Ontario and those interviewed from April 2012 to 2017 in Alberta. The 2 provinces combined represent roughly half of the country’s population.49 This sampling strategy maximized sample size while enabling us to identify emergency department visits in the past 2 years for variable construction. Other jurisdiction-years were excluded because of potential sampling bias. For instance, the optional reporting of emergency department records to the NACRS by certain hospitals in Manitoba or pre-2010 Alberta may be related to lower neighbourhood income — a contextual predictor of food insecurity — compared with nonreporting hospitals in the same jurisdiction-years, leading to spurious associations between emergency department visits and food insecurity. We did not include Yukon because of its limited data on food insecurity.

We linked CCHS respondents to NACRS records from 2003 to 2017 through unique person identifiers; those without NACRS records were presumed to not have attended an emergency department during the observation period. The CCHS–NACRS linkage rates in the raw data are 89.73% for Ontario and 84.16% for Alberta.50 Of the survey respondents in Ontario and Alberta, we excluded those with invalid food insecurity data and those from Ontario during 2015-2016, given Ontario’s opt-out from food insecurity monitoring (Appendix 1, Supplementary eFigure 1, available at www.cmajopen.ca/content/10/1/E8/suppl/DC1).

Measurements

Our primary outcomes were number of emergency department visits because of any pain and pain at different sites (migraine, other headaches, chest–throat pain, abdomen–pelvis pain, dorsalgia, joint pain, limb pain and other miscellaneous pain), measured over the 12-month period before CCHS interviews (Appendix 1, Supplementary eTable 1). We used ICD-10-CA codes for the main cause of the visit to build count variables for pain to capture the frequency and incidence rate of pain-driven emergency department visits (Appendix 1, Supplementary eTable 2). Pain as a symptom of other illnesses was common but beyond our study’s scope; therefore, joint causes of the visit were disregarded in variable building.

We further constructed secondary outcomes on characteristics of pain-driven emergency department visits for the past-year patients. They included number of emergency department visits driven by pain, visits of high acuity (resuscitation, emergent or urgent, as opposed to semiurgent or nonurgent), visits with multiple causes (1 or more causes, with pain being the main cause) and visits after hours (weekdays 00:00-7:59 or weekends 16:00-7:59).
Our key exposure was past-year household food insecurity status, with the same 12-month reference period as the outcomes. This is a 4-level categorical variable built from the 18-item questionnaire in the CCHS, which was developed and validated by the United States Department of Agriculture and adapted by Health Canada.\textsuperscript{51} On the basis of the number of affirmative answers, a household is classified as either food secure or marginally, moderately or severely food insecure.\textsuperscript{51,52}

We adjusted for factors that may confound the relation between food insecurity and pain-driven emergency department visits. These included respondents’ sex (male, female), age at interview (years), race or ethnicity (white, Black, Indigenous, others), immigrant status (Canadian-born, immigrant), tobacco smoking status (never, former, current), past-year alcohol consumption (none, up to once a week, more than once a week) and number of emergency department visits not driven by pain in the year before (13–24 months ago). We also controlled for household characteristics, such as highest education (high school incomplete, high school diploma, some college, college degree), housing tenure (renter, homeowner), household type (couple with children, couple without children, lone parent, other), province (Ontario, Alberta) and survey cycle. These variables have been found predictive of pain or emergency department use.\textsuperscript{16,20,21,23,24,40–43} Missing values for covariates were rare (<1% except education [4.4%]); therefore, for simplicity, we coted them as separate categories within each variable.\textsuperscript{53}

**Statistical analysis**

We first described sample characteristics by emergency department visit status and computed crude incidence rates of emergency department visits because of any pain and site-specific pain across food insecurity levels. To ascertain the significance of between-group differences, we applied Student $t$ tests for continuous variables and $\chi^2$ tests for categorical variables.

Owing to overdispersion (Pearson goodness-of-fit $\chi^2$ $p < 0.001$), we fitted negative binomial models on the count outcomes adjusting for confounding factors. Pain and emergency department use vary across demographic groups;\textsuperscript{23,24} thus, we also stratified our analyses on overall pain-driven emergency department visits by sex and age. We computed average predicted probability of the primary outcomes based on the adjusted models using marginal standardization. We then fitted adjusted negative binomial models on the secondary outcomes for the pain-driven emergency department visits.

We conducted sensitivity analyses expanding the sample to incorporate partial records from all jurisdictions, testing Poisson and zero-inflated negative binomial models, adjusting for household income, and experimenting with a broader definition of pain, considering diseases commonly associated with chronic pain, such as fibromyalgia.

We computed 2-sided confidence intervals (CIs) and set the significance at $p < 0.05$. All analyses were done with the sampling weights of CCHS in Stata SE 15.1. Numbers of observations were rounded to protect identity. Data and programming codes are stored in Statistics Canada’s Research Data Centre with restricted access.

**Ethics approval**

We obtained ethics approval from the Health Sciences Research Ethics Board at the University of Toronto.

**Results**

After excluding 29200 individuals with missing data on food insecurity, we reached the final sample of 212300 individuals aged 12 years and older in Ontario and Alberta (Appendix 1, Supplementary eFigure 1). Of these, 12000 had 1 or more pain-driven emergency department visit in the year before interview. After application of survey weights to obtain population estimates, of the 212300 sampled respondents, 7600 (3.9% of represented population), 10400 (5.5%) and 5400 (2.5%) lived in marginally, moderately and severely food-insecure households, respectively (Table 1). A total of 115600 (50.8%) women were in the sample. The average age at interview was 43.8 (standard deviation 19.0) years. Patients seen in the emergency department were socioeconomically more disadvantaged than nonvisitors (e.g., lower income, less education).

The incidence rate of pain-driven emergency department visits was 62 per 1000 person-years (Table 2). The comparable figures were 55 for food-secure individuals and 85, 109 and 167 for marginally, moderately and severely food-insecure individuals, respectively. Pain-driven emergency department visits were more common among women than men ($p < 0.05$ for all but moderately food-insecure people) and more common among adults than adolescents younger than 18 years ($p < 0.05$ for all). Abdomen–pelvis pain, chest–throat pain and dorsalgia were the most common types of pain driving emergency department visits.

Among those patients seen in the emergency department, each had on average 1.33 pain-driven emergency department visits, 0.39 visit with multiple causes, 0.90 high-acute visit and 0.82 visit during after-hours. Pain-driven emergency department visits were more common among those experiencing more severe food insecurity regardless of pain type, sex or age, with all trends significant at $p < 0.05$ except for adolescents 12–17 years old ($p = 0.3$). Patients seen for pain were also more likely to make more frequent, multicause, high-acute and after-hours emergency department visits if they were food insecure versus food secure (trends $p < 0.05$).

**Regression results**

Marginal, moderate and severe food insecurity were associated with 1.55 (95% CI 1.32–1.84), 1.99 (95% CI 1.62–2.44) and 3.05 (95% CI 2.50–3.71) times higher incidence rates of pain-driven emergency department visits, respectively (Table 3). The rate ratios shrank to 1.42 (95% CI 1.20–1.68), 1.64 (95% CI 1.37–1.96) and 1.99 (95% CI 1.61–2.46), respectively, after adjustment for confounders (Appendix 1, Supplementary eTables 3 and 4). The association was significant for males and females, and for adults younger than 65 years and adults aged 65 years and older (except for moderate food insecurity). No association with food insecurity was significant among adolescents.
Table 1 (part 1 of 2): Sample characteristics by past-year pain-driven emergency department visit status among respondents of the Canadian Community Health Survey 2005–2017

| Characteristic                        | % of respondents* | No pain-driven ED visit† | Any pain-driven ED visit† | Total n = 212 300 |
|--------------------------------------|-------------------|--------------------------|---------------------------|--------------------|
|                                      |                   | n = 200 300              | n = 12 000                 |                    |
| Household food insecurity            |                   |                          |                           |                    |
| Food security                        | 88.5              | 81.1                     | 88.1                      |                    |
| Marginal food insecurity             | 3.9               | 5.3                      | 3.9                       |                    |
| Moderate food insecurity             | 5.3               | 8.6                      | 5.5                       |                    |
| Severe food insecurity               | 2.3               | 4.9                      | 2.5                       |                    |
| Sex                                  |                   |                          |                           |                    |
| Male                                 | 49.7              | 40.5                     | 49.2                      |                    |
| Female                               | 50.3              | 59.5                     | 50.8                      |                    |
| Age, yr, mean ± SD                   | 43.7 ± 19.0       | 46.1 ± 19.3              | 43.8 ± 19.0               |                    |
| Race or ethnicity                    |                   |                          |                           |                    |
| White                                | 72.8              | 76.7                     | 73.0                      |                    |
| Black                                | 3.3               | 3.3                      | 3.3                       |                    |
| Indigenous                           | 20.4              | 13.7                     | 20.1                      |                    |
| Other                                | 2.6               | 5.1                      | 2.8                       |                    |
| Not stated                           | 0.9               | 1.2                      | 1.0                       |                    |
| Immigrant status                     |                   |                          |                           |                    |
| Canadian-born                        | 68.7              | 73.8                     | 69.0                      |                    |
| Immigrant                            | 30.8              | 25.6                     | 30.5                      |                    |
| Not stated                           | 0.5               | 0.6                      | 0.5                       |                    |
| Highest education in household       |                   |                          |                           |                    |
| High school incomplete               | 5.0               | 8.5                      | 5.2                       |                    |
| High school graduate                 | 10.8              | 13.8                     | 11.0                      |                    |
| Some college                         | 3.6               | 3.6                      | 3.6                       |                    |
| College degree                       | 75.2              | 68.7                     | 74.9                      |                    |
| Not stated                           | 5.4               | 5.4                      | 5.4                       |                    |
| Housing tenure                       |                   |                          |                           |                    |
| Renter                               | 23.4              | 29.9                     | 23.7                      |                    |
| Homeowner                            | 76.3              | 69.9                     | 76.1                      |                    |
| Not stated                           | 0.2               | 0.2                      | 0.2                       |                    |
| Household type                       |                   |                          |                           |                    |
| Couple with children                 | 48.3              | 42.3                     | 48.1                      |                    |
| Couple without children              | 25.2              | 26.7                     | 25.3                      |                    |
| Lone parent                          | 9.6               | 10.9                     | 9.6                       |                    |
| Other                                | 16.4              | 19.6                     | 16.6                      |                    |
| Not stated                           | 0.5               | 0.5                      | 0.5                       |                    |
| Province of residence                |                   |                          |                           |                    |
| Ontario                              | 85.4              | 81.9                     | 85.2                      |                    |
| Alberta                              | 14.6              | 18.1                     | 14.8                      |                    |
Broadening the definition of pain, adding partial emergency department records from other jurisdictions, adjusting for income, or fitting a Poisson or zero-inflated negative binomial model barely changed the results (Appendix 1, Supplementary eTable 5).

With few exceptions, females and adults tended to have higher incidence rates of pain-driven emergency department visits than their male and adolescent counterparts, respectively (Figure 1). However, neither sex nor age significantly moderated the association between food insecurity and pain-driven emergency department visits after confounders adjustment (all interactions \( p > 0.05 \)).

A graded association between food insecurity status and site-specific pain was found in the unadjusted models, with a more severe level of food insecurity linked to a greater incidence rate of emergency department visits because of pain at different sites (Table 4; Appendix 1, Supplemental eTable 6). After adjustment for confounding factors, the graded association with food insecurity status by and large persisted. Moderate and severe food insecurity were associated with pain at all sites except limb pain. Marginal food insecurity was significantly associated with migraine and chest–throat pain only. Abdomen–pelvis pain and chest–throat pain were the most likely causes behind pain-driven emergency department visits for food-secure and food-insecure people alike after confounders adjustment (Figure 2).

Among patients with a pain-driven emergency department visit in the past year (\( n = 12000 \)), moderate food insecurity was associated with more frequent (adjusted rate ratio 1.13, 95% CI 1.01–1.25) and after-hours (adjusted rate ratio 1.20, 95% CI 1.04–1.40) pain-driven emergency department visits. Severe food insecurity was associated with more frequent (adjusted rate ratio 1.32, 95% CI 1.15–1.50), multicause (adjusted rate ratio 1.50, 95% CI 1.19–1.88), high-acuity (adjusted rate ratio 1.37, 95% CI 1.17–1.61) and after-hours (adjusted rate ratio 1.29, 95% CI 1.10–1.51) pain-driven emergency department visits (Table 5; Appendix 1, Supplemental eTable 7). Marginal food insecurity was not significantly related to characteristics of emergency department visits.

### Table 1 (part 2 of 2): Sample characteristics by past-year pain-driven emergency department visit status among respondents of the Canadian Community Health Survey 2005–2017

| Characteristic | % of respondents* | No pain-driven ED visit† | Any pain-driven ED visit† | Total |
|---------------|-------------------|--------------------------|--------------------------|-------|
|               |                   | \( n = 200300 \)         | \( n = 12000 \)          | \( n = 212300 \) |
| Tobacco smoking status | | | | |
| Never smoked | 46.2 | 38.3 | 45.9 |
| Former smoker | 35.3 | 37.7 | 35.4 |
| Current smoker | 18.3 | 23.9 | 18.6 |
| Not stated | 0.1 | 0.2 | 0.1 |
| Past-year alcohol consumption | | | | |
| None | 46.4 | 48.4 | 46.6 |
| Any up to once a week | 25.2 | 29.1 | 25.4 |
| More than once a week | 28.1 | 22.3 | 27.8 |
| Not stated | 0.3 | 0.2 | 0.3 |
| CCHS cycle | | | | |
| Cycle 2005–2006 | 7.9 | 7.8 | 7.9 |
| Cycle 2007–2008 | 16.5 | 14.9 | 16.4 |
| Cycle 2009–2010 | 16.9 | 15.8 | 16.9 |
| Cycle 2011–2012 | 19.1 | 20.0 | 19.1 |
| Cycle 2013–2014 | 22.7 | 21.9 | 22.7 |
| Cycle 2015–2016 | 5.2 | 6.7 | 5.2 |
| Cycle 2017 | 11.8 | 12.9 | 11.8 |
| Non–pain-driven ED visit 13–24 months ago | | | | |
| Frequency, mean ± SD | 0.7 ± 4.2 | 1.9 ± 7.2 | 0.7 ± 4.4 |

Note: CCHS = Canadian Community Health Survey, ED = emergency department, SD = standard deviation. All statistics were weighted by sampling weights of CCHS.
*Unless stated otherwise.
†All differences between “any pain” and “no pain” are significant at \( p < 0.05 \) based on \( \chi^2 \) test for categorical variables and \( t \) test for age and frequency of ED visits in the year before.
Interpretation

Using multiyear emergency department records from 2 populous Canadian provinces, we found that food insecurity status was associated with pain-driven emergency department visits in a graded fashion. The association was similar across sex and age, and significant among adults but not adolescents. Among patients with pain-driven emergency department visits, severe food insecurity was associated with more frequent, multicause, high-acuity and after-hours visits. The results are consistent with past literature on pain and emergency department visits, further confirming food insecurity as a determinant of health and health service use.\textsuperscript{14–21,60–43} The alignment of our findings with the literature highlights the disproportionate burden that food insecurity places on the Canadian health care system.\textsuperscript{15,16} Although pain is more prevalent among women than men for biological and social reasons,\textsuperscript{23} food insecurity affected both sexes’ risk of pain-driven emergency department visits similarly. Adolescents’ use of emergency departments for pain is rare compared with adults’ use and, as shown in population research in Canada and elsewhere, often related to sports or recreational injury rather than economic disadvantages,\textsuperscript{24,44} which may explain the null association of food insecurity with pain-driven emergency department visits among adolescents. An earlier study found that adults visiting the emergency department for chest

| Variable | Incidence rate per 1000 person-years‡ |
|----------|--------------------------------------|
|          | Food security | Marginal food insecurity | Moderate food insecurity | Severe food insecurity | Total |
| Overall and by sex and age | | | | | |
| No. of respondents | 188 900 | 7600 | 10 400 | 5400 | 212 300 |
| Pain-driven ED visits | 55 | 85 | 109 | 167 | 62 |
| Male, n = 96 700 | 46 | 61 | 100 | 113 | 50 |
| Female, n = 115 600 | 64 | 106 | 115 | 205 | 73 |
| 12–17 yr, n = 18 600 | 30 | 27§ | 39§ | 43§ | 31 |
| 18–64 yr, n = 140 200 | 54 | 91 | 121 | 177 | 63 |
| ≥ 65 yr, n = 53 500 | 70 | 119§ | 101§ | 229 | 73 |
| Site-specific pain-driven ED visits | | | | | |
| Migraine | 3 | 8 | 7§ | 11 | 3 |
| Other headaches | 4 | 6§ | 11 | 14 | 5 |
| Chest–throat pain | 15 | 20§ | 28§ | 33 | 16 |
| Abdomen–pelvis pain | 17 | 28 | 32 | 58 | 20 |
| Dorsalgia | 9 | 13§ | 16 | 27 | 10 |
| Joint pain | 3 | 4§ | 6§ | 9§ | 3 |
| Limb pain | 3 | 3§ | 5§ | 6 | 3 |
| Other pain | 2 | 3§ | 4 | 9 | 2 |
| Pain-driven ED visitors subsample | | | | | |
| No. of pain-driven ED visitors | 9900 | 600 | 900 | 600 | 12 000 |
| Pain-driven ED visits‡ | | | | | |
| Total | 1287 | 1373§ | 1496 | 1787 | 1334 |
| Multicause | 381 | 435§ | 368§ | 585 | 393 |
| High acuity | 861 | 943§ | 1030 | 1238 | 899 |
| After hours | 782 | 830§ | 1027 | 1097 | 821 |

Note: ED = emergency department; ICD-10-CA = International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Canada.\textsuperscript{1} Trend analyses on food insecurity status are all significant at $p < 0.05$ except for adolescents 12–17 years old ($p = 0.3$).\textsuperscript{1} Unless stated otherwise.\textsuperscript{‡} “Pain-driven ED visits” refers to pain-driven ED visits during the past 12 months. “Multicause” refers to visits with any ICD-10-CA–coded joint cause beside the main cause. “High acuity” refers to visits requiring resuscitation, emergent or urgent care as opposed to semurgent or nonurgent treatment. “After hours” refers to visits made between 00:00 and 7:59 from Mondays to Fridays or between 16:00 and 7:59 on Saturdays and Sundays.§ Not significant (all other differences between food insecure and food secure are significant at $p < 0.05$.)
pain were more than twice as likely to die in 5 years as those of similar ages without chest pain, mostly because of ischemic heart disease.\textsuperscript{55} Whether food insecurity aggravates the association between pain and more serious clinical outcomes, such as death, warrants investigation.

The association of food insecurity with headaches aligns with past findings\textsuperscript{20,21} and reinforces the notion that chronic stress and mental health problems are among the most salient health challenges facing food-insecure people.\textsuperscript{15–17} Both migraine and tension headaches have been prospectively associated with depression and other mental disorders.\textsuperscript{56} Chronic stress, common among food-insecure families, is a key determinant of the migraine–depression comorbidity.\textsuperscript{57} Headaches may mediate the association between food insecurity and mental health problems, yet more research is needed to assess this possibility.

### Table 3: Negative binomial models on past-year pain-driven emergency department visits in the overall sample and by sex and age subsamples\textsuperscript{a}

| Variable                                    | Rate ratio (95% CI)     |
|---------------------------------------------|-------------------------|
|                                             | Food security           | Marginal food insecurity | Moderate food insecurity | Severe food insecurity |
| Pain-driven ED visits, unadjusted, n = 212 300 | Ref. 1.55 (1.32–1.84)   | 1.99 (1.62–2.44)         | 3.05 (2.50–3.71)        |
| Pain-driven ED visits, n = 212 300          | Ref. 1.42 (1.20–1.68)   | 1.64 (1.37–1.96)         | 1.96 (1.48–2.46)        |
| Male, n = 96 700                            | Ref. 1.37 (1.07–1.74)   | 1.99 (1.46–2.72)         | 1.96 (1.48–2.61)        |
| Female, n = 115 600                         | Ref. 1.45 (1.15–1.81)   | 1.42 (1.17–1.73)         | 1.93 (1.47–2.52)        |
| 12–17 yr, n = 18 600                        | Ref. 0.96 (0.53–1.75)   | 1.42 (0.82–2.47)         | 1.43 (0.67–3.05)        |
| 18–64 yr, n = 140 200                       | Ref. 1.41 (1.18–1.69)   | 1.65 (1.36–2.00)         | 1.88 (1.49–2.37)        |
| ≥ 65 yr, n = 53 500                         | Ref. 1.75 (1.04–2.97)   | 1.36 (0.90–2.06)         | 3.77 (1.95–7.28)        |

Note: CCHS = Canadian Community Health Survey, CI = confidence interval, ED = emergency department, Ref. = reference category.

\*All models are weighted by CCHS survey weights. With the exception of the unadjusted model on any pain-driven ED visit, all models adjusted for sex, age, race or ethnicity, immigrant status, highest education in household, housing tenure, household type, jurisdiction of residence, smoking status, past-year alcohol consumption, CCHS cycle and frequency of non–pain-driven ED visit in the year before.

### Figure 1: Adjusted predicted probability of past-year pain-driven emergency department visits by food insecurity status, in overall sample and by sex and age subsamples.

All models adjusted for sex, age, race or ethnicity, immigrant status, highest education in household, housing tenure, household type, jurisdiction of residence, smoking status, past-year alcohol consumption, Canadian Community Health Survey cycle and frequency of non–pain-driven emergency department visit in the year before. Black vertical lines indicate 95% confidence intervals.
Body pain often signals undiagnosed morbidities. Cancer, nervous system injury (e.g., stroke), and damage to or inflammation of organs (e.g., ischemic heart disease) can all cause severe pain, especially at later stages, when socioeconomically disadvantaged individuals are more likely to receive diagnoses of cancer and other chronic diseases than their less disadvantaged counterparts. Pain-driven emergency department visits may be the first opportunity to detect pain-related chronic diseases for a disproportionate share of food-insecure patients, which is a hypothesis awaiting validation. The correlations between severe food insecurity and joint and back pain may be related to overexertion caused by strenuous low-wage work. Food-insecure patients had more after-hours emergency department visits than their food-secure counterparts, which may relate to their greater probability of having inflexible work schedules (e.g., no sick leave) and less manageable pain (e.g., unable to wait until daytime hours). The reduced emergency department staff after hours may subject food-insecure patients to less effective pain management than they would have obtained during daytime hours, a hypothesis awaiting validation. Repeated, high-acuity and multicause emergency department visits for pain may indicate that complications of chronic conditions become more likely as food insecurity worsens to the severe level.

Our study connected food insecurity to pain-driven emergency department visits, with plausible research and policy implications. The evidence so far suggests that food insecurity may magnify health problems, warranting policy interventions. Income supplements to low-resource populations have been effective in lowering food insecurity. Further investigation is needed to evaluate the effects of income supplements on pain and emergency department use.

Frequent visits to the emergency department may indicate inadequate access to other health care services, such as primary care. Researchers and policy-makers need to assess food-insecure patients’ access to primary care, as it may help reduce the burden on the emergency department. Virtual visits have shown promising signs of replacing, at least partly, in-person primary care; meanwhile, increasing after-hours physician services has moderately lowered use of emergency departments. These discussions are especially meaningful during the ongoing pandemic when food insecurity is rising while in-person meeting is minimized. However, accessibility of technology for virtual consultation (e.g., broadband Internet) remains questionable for socioeconomically disadvantaged populations.

Moreover, it is important to lower the financial barriers to prescription pain relievers and pain management services, such as physiotherapy and psychotherapy. Physicians in Canada have

| Variable                        | Rate ratio (95% CI) | Unadjusted | Marginal food insecurity | Moderate food insecurity | Severe food insecurity |
|---------------------------------|---------------------|------------|--------------------------|--------------------------|------------------------|
| Unadjusted                      |                     |            |                          |                          |                        |
| Migraine                        | Ref.                | 2.72 (1.33–5.56) | 2.39 (1.16–4.91)         | 4.04 (2.24–7.29)         |                        |
| Other headaches                 | Ref.                | 1.48 (0.97–2.28) | 2.51 (1.62–3.87)         | 3.24 (2.06–5.09)         |                        |
| Chest–throat pain               | Ref.                | 1.38 (0.99–1.92) | 1.92 (1.18–3.12)         | 2.27 (1.80–2.86)         |                        |
| Abdomen–pelvis pain             | Ref.                | 1.62 (1.24–2.11) | 1.84 (1.45–2.34)         | 3.32 (2.44–4.52)         |                        |
| Dorsalgia                       | Ref.                | 1.53 (1.06–2.20) | 1.82 (1.35–2.45)         | 3.13 (1.87–5.25)         |                        |
| Joint pain                      | Ref.                | 1.42 (0.84–2.41) | 2.39 (1.14–5.01)         | 3.55 (1.46–8.64)         |                        |
| Limb pain                       | Ref.                | 1.07 (0.68–1.69) | 1.75 (1.09–2.81)         | 1.99 (1.24–3.20)         |                        |
| Other pain                      | Ref.                | 1.97 (0.82–4.71) | 2.87 (1.65–4.99)         | 5.79 (2.78–12.04)        |                        |
| Adjusted                        |                     |            |                          |                          |                        |
| Migraine                        | Ref.                | 2.81 (1.62–4.88) | 2.00 (1.16–3.47)         | 3.03 (1.81–5.06)         |                        |
| Other headaches                 | Ref.                | 1.33 (0.91–1.95) | 2.26 (1.51–3.37)         | 2.57 (1.63–4.05)         |                        |
| Chest–throat pain               | Ref.                | 1.48 (1.04–2.10) | 1.86 (1.31–2.65)         | 1.94 (1.51–2.51)         |                        |
| Abdomen–pelvis pain             | Ref.                | 1.24 (0.98–1.58) | 1.32 (1.02–1.71)         | 1.74 (1.23–2.44)         |                        |
| Dorsalgia                       | Ref.                | 1.41 (0.97–2.04) | 1.56 (1.12–2.19)         | 2.12 (1.22–3.68)         |                        |
| Joint pain                      | Ref.                | 1.51 (0.84–2.74) | 1.94 (1.23–3.07)         | 2.19 (1.22–3.96)         |                        |
| Limb pain                       | Ref.                | 1.00 (0.63–1.59) | 1.60 (0.92–2.78)         | 1.50 (0.91–2.48)         |                        |
| Other pain                      | Ref.                | 2.08 (0.93–4.65) | 2.32 (1.19–4.53)         | 4.33 (1.72–10.88)        |                        |

Note: CCHS = Canadian Community Health Survey, CI = confidence interval, ED = emergency department, Ref. = reference category.

*All models are weighted by CCHS survey weights. Adjusted negative binomial models adjusted for sex, age, race or ethnicity, immigrant status, highest education in household, housing tenure, household type, jurisdiction of residence, smoking status, past-year alcohol consumption, CCHS cycle and number of non–pain-driven ED visits in the year before.
raised concerns about dispensing of opioid-based analgesics in light of the rampant opioid crisis disproportionately hurting marginalized groups, especially food-insecure people. However, out-of-pocket expenses on non-opioid treatment may hinder proper pain management at early stages and increase the burden on the health care system by forcing patients with pain into free-of-charge, yet resource-intensive, emergency department use and hazardous coping strategies, such as illicit opioid use.

Figure 2: Adjusted predicted probability of past-year emergency department visits driven by site-specific pain, by food insecurity status in overall sample (n = 212,300). All models adjusted for sex, age, race or ethnicity, immigrant status, highest education in household, housing tenure, household type, jurisdiction of residence, smoking status, past-year alcohol consumption, Canadian Community Health Survey cycle and frequency of non–pain-driven emergency department visit in the year before. Black vertical lines indicate 95% confidence intervals.

Table 5: Adjusted negative binomial models on characteristics of emergency department visits among pain-driven visitors*

| Variable                     | Rate ratio (95% CI)       |
|------------------------------|---------------------------|
|                              | Food security             | Marginal food insecurity | Moderate food insecurity | Severe food insecurity |
| Pain-driven ED visits, n = 12,000† |                           |                          |                          |                         |
| Total                        | Ref.                      | 1.05 (0.97–1.14)         | 1.13 (1.01–1.25)         | 1.32 (1.15–1.50)       |
| Multicause                   | Ref.                      | 1.16 (0.93–1.44)         | 0.97 (0.78–1.21)         | 1.50 (1.19–1.88)       |
| High acuity                  | Ref.                      | 1.06 (0.93–1.19)         | 1.11 (0.98–1.26)         | 1.37 (1.17–1.61)       |
| After hours                  | Ref.                      | 1.02 (0.88–1.18)         | 1.20 (1.04–1.40)         | 1.29 (1.10–1.51)       |

Note: CCHS = Canadian Community Health Survey; CI = confidence interval; ED = emergency department; ICD-10-CA = International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Canada; Ref. = reference category.

*All models are weighted by CCHS survey weights and adjusted for sex, age, race or ethnicity, immigrant status, highest education in household, housing tenure, household type, jurisdiction of residence, smoking status, past-year alcohol consumption, CCHS cycle and number of non–pain-driven ED visits in the year before.

†“Pain-driven ED visits” refers to pain-driven ED visits during the past 12 months. “Multicause” refers to visits with any ICD-10-CA–coded joint cause beside the main cause. “High acuity” refers to visits requiring resuscitation, emergent or urgent care, rather than semurgence or nonurgent treatment. “After hours” refers to pain-driven ED visits made between 00:00 and 7:59 from Mondays to Fridays or between 16:00 and 7:59 on Saturdays and Sundays.
Limitations
Our findings need to be interpreted with caveats. The results are correlational; the cross-sectional design prevents us from establishing causal directions. The possibility of unobserved confounders having led to food insecurity and emergency department visits simultaneously cannot be ruled out. Other data sets may allow examination of potential mediating effects of occupation, injury and chronic diseases on the correlation between food insecurity and pain-driven emergency department visits. Adjusting for prior emergency department visits could not eliminate selection bias; longitudinal data with repeated measurements of food insecurity are needed to ascertain causality. Moreover, although adding in partial records from all jurisdictions did not affect the results, our sample was in essence restricted to the individuals with measurement of food insecurity in Ontario and Alberta. Future studies may validate our findings elsewhere.

Conclusion
Household food insecurity status is significantly associated with pain-driven emergency department visits in the Canadian population. Policies targeting food insecurity may reduce pain and health care utilization, warranting further research.

References
1. Shupler MS, Kramer JK, Craig JJ, et al. Pan-Canadian estimates of chronic pain prevalence from 2000 to 2014: a repeated cross-sectional survey analysis. J Pain 2019;20:557-65.
2. Dalhaimer J, Lucas J, Zelaya C, et al. Prevalence of chronic pain and high-impact chronic pain among adults — United States, 2016. MMWR Morb Mortal Wkly Rep 2018;67:1001-6.
3. Lynch ME. The need for a Canadian pain strategy. Pain Res Manag 2011;16:77-80.
4. NACRS emergency department visits and length of stay by province/territory, 2017–2018. Ottawa: Canadian Institute for Health Information; 2018.
5. Volkow N, Baldock E, Chett M, et al. Food insecurity and mental illness: disproportionate impacts in the context of perceived stress and social isolation. Public Health 2016;132:86-91.
6. Blackburn-Munro G, Blackburn-Munro RE. Chronic pain, chronic stress and depression: Coincidence or consequence? J Neuroword 2001;15:1009-23.
7. McFarlane IA, Barrie A, Emery J. When working is not enough: food insecurity in the Canadian labour force. Public Health Nutr 2014;17:49-57.
8. von Hecke O, Lynne T, Tanamani N, et al. Chronic pain, depression and cardio-vascular disease linked through a shared genetic predisposition: analysis of a family-based cohort and twin study. PLoS One 2017;12:e0170653.
9. Haack M, Simpson N, Sethna N, et al. Sleep deprivation and chronic pain: potential underlying mechanisms and clinical implications. Neuropharmacology 2020;15:205-16.
10. Arenas DJ, Thomas A, Wang J, et al. A systematic review and meta-analysis of depression, anxiety, and sleep disorders in US adults with food insecurity. J Behav Med 2020;43:1254-68.
11. Umeda M, Ullevig SL, Chung E, et al. Depression mediates the relationship between food insecurity and pain interference in college students. Int J Environ Res Public Health 2020;18:18010078.
12. Men F, Gundersen C, Urquia ML, et al. Prescription medication nonadherence associated with food insecurity: a population-based cross-sectional study. CMAJ Open 2019;7:E590-7.
13. Kurlander JE, Kerr EA, Krein S, et al. Cost-related nonadherence to medications among patients with diabetes and chronic pain: factors beyond finances. Diabetes Care 2009;32:2141-8.
14. Ontario Health Insurance Plan (OHIP) Funded Physiotherapy Services. Ontario Community Physiotherapy Program: what is not covered. Available: https://www.ohiphealth.ca/service/ohip-physiotherapy-services/(accessed 2021 Nov. 25).
15. Brau K, Burrows TL, Rollo ME, et al. A systematic review and meta-analysis of nonpharmacological interventions for chronic noncancer pain. J Hum Nutr Diet 2019;32:198-225.
16. Coleman-Jensen AJ. Working for peanuts: nonstandard work and food insecurity across household structure. J Fam Econ Issues 2011;32:84-97.
17. Guttman A, Shipman SA, Lam K, et al. Primary care physician supply and children’s health care use, access, and outcomes: findings from Canada. Pediatrics 2010;125:1119-26.
18. Kirkpatrick SL, Dool KD, Parsons R, et al. Household food insecurity is a stronger marker of adequacy of nutrient intakes among Canadian compared to American youth and adults. J Nutr 2015;145:1596-603.
19. Olah ME, Gaisano G, Hwang SW. The effect of socioeconomic status on access to primary care: an audit study. CMAJ 2013;185:E263-9.
20. Tarasuk V, Cheng J, Gundersen C, et al. Association between household food insecurity and annual health care costs. CMAJ 2015;187:E429-36.
21. Berkowitz SA, Seligman HK, Meigs J, et al. Food insecurity, health care utilization, and high cost: a longitudinal cohort study. Am J Manag Care 2018;24:510E-514E.
22. Pelz A, Garg A. Food insecurity and health care use. Pediatrics 2019;144:e20190347.
23. Cotti CD, Gordanier JM, Ozurt OD. Hunger pains? SNAP timing and emergency room visits. J Health Econ 2020;71:102313.
24. Benchimol EM, Smeth L, Guttman A, et al.; RECORD Working Committee. The reporting of studies conducted using observational routinely-collected health data (RECORD) statement. PLoS Medicine 2015 Oct 6;12(10):e1001885.
25. Canadian Community Health Survey — annual component (CCHS). Ottawa: Statistics Canada; 2018.
26. Canadian Community Health Survey (CCHS): annual component. User guide. 2016 microdata file. Ottawa: Statistics Canada; 2017.
27. Canadian Community Health Survey (CCHS): annual component. User guide. 2007 microdata file. Ottawa: Statistics Canada; 2008.
28. National Ambulatory Care Reporting System metadata (NACRS). Ottawa: Canadian Institute for Health Information; 2021. Available: https://www.cihi.ca/en/national-ambulatory-care-reporting-system-metadata-nacrs (accessed 2021 July 10).
29. Canada at a glance 2018: population. Ottawa: Statistics Canada; modified 2018 Mar. 27.
30. CCHS-NACRS linkage user guide. Ottawa: Statistics Canada; 2020.
31. Canadian Community Health Survey (CCHS): annual component (2006) — income-related household food security in Canada [supplementary data tables]. Ottawa: Statistics Canada; 2007. Cat no H164-4/2 2007E.
52. Determining food security status. Ottawa: Health Canada; 2020. Available: https://www.canada.ca/en/health-canada/services/food-nutrition/food-nutrition-surveillance/health-nutrition-surveys/canadian-community-health-survey-cchs/household-food-insecurity-canada-overview/determining-food-security-status-food-nutrition-surveillance-health-canada.html (accessed 2020 Nov. 18).

53. Jones MP. Indicator and stratification methods for missing explanatory variables in multiple linear regression. J Am Stat Assoc 1996;91:222-30.

54. Potter BK, Speechley KN, Koval JJ, et al. Socioeconomic status and non-fatal injuries among Canadian adolescents: variations across SES and injury measures. BMJ Public Health 2005;5:132.

55. Geraldine McMahon C, Yates DW, Hollis S. Unexpected mortality in patients discharged from the emergency department following an episode of nontraumatic chest pain. Eur J Emerg Med 2008;15:3-8.

56. Bredow N, Schultz LR, Stewart WF, et al. Headache and major depression: Is the association specific to migraine? Neurology 2000;54:108-13.

57. Swanson SA, Zeng Y, Weeks M, et al. The contribution of stress to the comorbidity of migraine and major depression: results from a prospective cohort study. BMJ Open 2013;3:e002057.

58. Treede R-D, Rief W, Barke A, et al. Chronic pain as a symptom or a disease: the IASP Classification of Chronic Pain for the International Classification of Diseases (ICD-11). Pain 2019;160:19-27.

59. Booth CM, Li G, Zhang-Salomons J, et al. The impact of socioeconomic status on stage of cancer at diagnosis and survival: a population-based study in Ontario, Canada. Cancer 2010;116:4160-7.

60. LaCalle E, Rabin E. Frequent users of emergency departments: the myths, the data, and the policy implications. Ann Emerg Med 2010;56:82-8.

61. Brown EM, Tarasuk V. Money speaks: Reductions in severe food insecurity follow the Canada Child Benefit. Prev Med 2019;129:105876.

62. Li N, Dachner N, Tarasuk V. The impact of changes in social policies on household food insecurity in British Columbia, 2003-2012. Prev Med 2016;92:151-8.

63. Loopstra R, Dachner N, Tarasuk V. An exploration of the unprecedented decline in the prevalence of household food insecurity in Newfoundland and Labrador, 2007-2012. Can Public Policy 2015;41:191-206.

64. Tarasuk V, Li N, Dachner N, et al. Household food insecurity in Ontario during a period of poverty reduction, 2005-2014. Can Public Policy 2019;45:93-104.

65. Men F, Urquia ML, Tarasuk V. The role of provincial social policies and economic environment in shaping household food insecurity among families with children in Canada. Prev Med 2021;148:106558.

66. Stamenova V, Agarwal P, Kelley L, et al. Uptake and patient and provider communication modality preferences of virtual visits in primary care: a retrospective cohort study in Canada. BMJ Open 2020;10:e037064.

67. Mehta, N, Kpelitse, KA, Devlin, RA, et al. Primary care access and emergency department utilization: Theory and evidence from Canada. Toronto: Canadian Centre for Health Economics; 2017.

68. McConaughy JW, Goldberg RM, Neogi PK, et al. Digital haves and have-nots: Internet and broadband usage in Canada and the United States. TPRC 41: The 41st Research Conference on Communication, Information and Internet Policy. 2013 Aug. 15. Available: https://ssrn.com/abstracts=2241819 (2021 Nov. 25).

69. Opioid prescribing in Canada: How are practices changing? Ottawa: Canadian Institute for Health Information; 2019.

70. Corscadden L, Callander EF, Topp SM. Who experiences unmet need for mental health services and what other barriers to accessing health care do they face? Findings from Australia and Canada. Int J Health Plans Manage 2019;34:761-72.

71. Voon P, Greer AM, Amlani A, et al. Pain as a risk factor for substance use: a qualitative study of people who use drugs in British Columbia, Canada. Harm Reduct J 2018;15:15.

Affiliations: Department of Nutritional Sciences (Men, Tarasuk), University of Toronto, Toronto, Ont.; Department of Consumer Sciences (Men), The University of Alabama, Tuscaloosa, Ala.; Department of Community Health Sciences (Urquia), University of Manitoba, Winnipeg, Man.; Dalla Lana School of Public Health (Urquia), University of Toronto; Li Ka Shing Knowledge Institute (Urquia), St. Michael’s Hospital, Toronto, Ont.

Contributors: Fei Men, Valerie Tarasuk and Marcelo Urquia contributed to the conception of the study. Valerie Tarasuk acquired the data. Fei Men designed the study, analyzed and interpreted the data, prepared the tables and figures, and drafted the manuscript. Valerie Tarasuk, Marcelo Urquia, and Fei Men revised the manuscript for important intellectual content. All authors gave final approval of the version to be published and agreed to be accountable for all aspects of the work.

Funding: This study was supported by the Canadian Institutes of Health Research grant PJT 153260, awarded to Valerie Tarasuk and Marcelo Urquia. The funder had no role in the design and conduct of the study; collection, management, analysis and interpretation of data; or preparation, review, decision to submit for publication or approval of the manuscript.

Content licence: This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY-NC-ND 4.0) licence, which permits use, distribution and reproduction in any medium, provided that the original publication is properly cited, the use is noncommercial (i.e., research or educational use), and no modifications or adaptations are made. See: https://creativecommons.org/licenses/by-nc-nd/4.0/

Data sharing: Data from this study cannot be shared publicly owing to the confidentiality agreement between Statistics Canada and respondents of the Canadian Community Health Survey. Data are available from the Statistics Canada Research Data Centre (telephone 905-525-9140 ext. 23661) for researchers who meet the criteria for access to confidential data.

Acknowledgements: This research was conducted at Toronto Research Data Centre, a part of the Canadian Research Data Centre Network. This service is provided through the support of the University of Toronto, the Canada Foundation for Innovation, the Canadian Institutes of Health Research, the Social Sciences and Humanities Research Council, and Statistics Canada. All views expressed in this work are the authors’ own. The authors thank the Canadian Institutes of Health Research for funding. The authors thank the reviewers for their constructive feedback.

Supplemental information: For reviewer comments and the original submission of this manuscript, please see www.cmajopen.ca/content/10/1/ES/suppl/DC1.