

Prescription medication nonadherence associated with food insecurity: a population-based cross-sectional study

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Abstract

Background: Food insecurity, defined as inadequate access to food owing to financial constraints, has been associated with poor disease management. Because cost-related nonadherence to prescription drugs is a possible explanation for such association, we examined the link between food insecurity and cost-related medication nonadherence in Canada.

Methods: Drawing on data for adult respondents (age ≥ 18 yr) who participated in the Canadian Community Health Survey 2016 Rapid Response module on prescription medication use, we assessed the association between household food insecurity and cost-related nonadherence to prescription drugs in the previous 12 months. We further examined the self-perceived health consequences of cost-related nonadherence among nonadherents. We applied Poisson models with bootstrap weights adjusting for sociodemographic characteristics.

Results: Of the 11 172 respondents in our sample, 930 (8.3%) reported cost-related nonadherence. Food insecurity affected 10.5% (95% confidence interval [CI] 9.1% to 11.8%) of adherents and 47.9% (95% CI 38.1% to 57.7%) of nonadherents. After adjustment for confounders, moderate and severe food insecurity were associated with 3.83 (95% CI 2.44 to 6.03) and 5.05 (95% CI 3.27 to 7.81) times higher prevalence of cost-related nonadherence, respectively, relative to food security. Despite being associated with lower probability of cost-related nonadherence, having drug insurance did not change the relation between food insecurity and cost-related nonadherence ($p > 0.1$ for all interactions). Severe food insecurity was correlated with higher prevalence of health deterioration and greater use of health care services as perceived consequences of cost-related nonadherence ($p < 0.01$ for both).

Interpretation: Food-insecure adults in Canada have a higher likelihood of cost-related nonadherence to prescription medications than their food-secure counterparts, which may constitute a burden on their health and lead to greater use of health care services.

Prescription drugs in Canada are covered by a patchwork of public and private insurance. Social assistance recipients are generally covered by public insurance, as are most older adults and Aboriginal people,¹ but most working-age adults rely on private insurance linked to their employment.² For those with no other drug coverage, provincial governments offer catastrophic insurance that caps the out-of-pocket expenses to a fixed amount or percentage of income.³ Yet there are over 4 million Canadians not enrolled in a drug insurance plan.⁴ Moreover, deductibles, coinsurance and copayment are common out-of-pocket expenses in both public and private insurance programs.¹ Law and colleagues⁵ conducted a population-based cross-sectional survey to study the consequences of patient charges for prescription drugs in Canada in 2016. They estimated that cost-related medication nonadherence — delaying, reducing or skipping prescribed medication owing to cost — was experienced by 8.2% of Canadians with a prescription in the previous year. The rate was especially high for young adults, lower-income households and those without drug insurance. An estimated 4.7% of

Canadians cut other expenses to afford prescription drugs, with half of them reducing food spending,⁵ which suggests a link to household food insecurity.

Food insecurity, defined as inadequate access to food owing to financial constraints, affected 12.6% of Canadian households in 2012.⁶ It has been linked to increased prevalence of chronic conditions,⁷ poorer disease management,^{8–10} greater use of health care services^{11,12} and higher mortality risk in Canada.¹³ The mechanisms by which food insecurity affects health remain largely unknown, but cost-related nonadherence is one potential pathway. Financially vulnerable households often make trade-offs among necessities such as food and medication.^{14–16} Depending on the degree of financial

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constraint and factors such as spending priorities, households may sacrifice spending on medications to purchase needed food or vice versa, or they may compromise spending in both categories.^{14–16} The accumulation of disadvantages has been documented in Canada and the United States, with food-insecure households often simultaneously experiencing multiple material and financial hardships, including high out-of-pocket medical expenses.^{17–20} Population-based studies have also associated food insecurity with cost-related nonadherence among US adults;^{16,21,22} however, little is known about this relation in Canada despite its plausibility.

Building on the work of Law and colleagues,⁵ we used cross-sectional data to test the hypothesis that cost-related medication nonadherence increases with severity of food insecurity among Canadian adults. Because poor adherence to medications may compromise food-insecure patients' management of chronic conditions and increase their risk for more serious health outcomes, we also explored the relation of food insecurity with forgoing drugs for chronic conditions and perceived health consequences of cost-related nonadherence.

Methods

Data sources

The Canadian Community Health Survey is a cross-sectional telephone survey conducted annually by Statistics Canada representing 98% of the Canadian community-dwelling population aged 12 years or more. Since 2015, samples of 65 000 households per year have been drawn from geographic area and Canadian Child Tax Benefit frames, with 1 household member selected randomly to answer questions. From January to June 2016, a rapid response component on prescription drug use was administered to respondents in the 10 provinces, with a person-level response rate of 85.3%.²³ Household food insecurity was also assessed in the survey; however, Ontario, Newfoundland and Labrador and the Yukon Territory opted out of this measurement in 2016.

Setting

Our sample included households that participated in both the rapid response component and the food security module. We excluded the territories as well as respondents interviewed after June 2016 (who therefore did not participate in the rapid response component). We also excluded respondents with missing food security status, including all those from Ontario and Newfoundland and Labrador. Of the remaining respondents, we retained those aged 18 years or more who had at least 1 drug prescription in the previous year and no missing data on cost-related nonadherence.

Outcomes

Our primary outcome was cost-related medication nonadherence conditional on receiving a drug prescription. The outcome derived from 2 survey questions regarding 1) not filling or collecting a drug prescription or skipping doses in the previous 12 months because of cost and 2) reducing dosage or delaying filling in the previous 12 months because of cost (see

Appendix 1, available at www.cmajopen.ca/content/7/3/E590/suppl/DC1, for questionnaire). A response of “yes” to either question constituted nonadherence.

To explore the possibility that cost-related nonadherence mediates the linkage between food insecurity and health, we also examined nonadherence to drugs for major chronic conditions and self-perceived health consequences of cost-related nonadherence as secondary outcomes. We created 3 binary indicators for the nonadherent subsample: 1) whether the unafforded drug was for cancer, heart disease, high cholesterol level, high blood pressure, asthma, chronic obstructive pulmonary disease, diabetes, gut problems, arthritis, chronic pain or mental disorders, 2) whether the respondent perceived that his or her health had worsened as a consequence of inability to afford prescription medications and 3) whether the respondent reported visiting a doctor, being admitted to hospital or going to the emergency department because of cost-related medication nonadherence.

Exposure

Our exposure of interest was household food insecurity. Based on the number of affirmative answers to 18 questions on a household's access to food over the previous 12 months (Appendix 2, available at www.cmajopen.ca/content/7/3/E590/suppl/DC1), we categorized households as “food secure,” “marginally food insecure,” “moderately food insecure” or “severely food insecure” (Supplementary Table S1, Appendix 3, available at www.cmajopen.ca/content/7/3/E590/suppl/DC1).

We adjusted for confounding factors associated with cost-related nonadherence in Canada,²⁴ including household income, prescription insurance, age and province of residence. We also controlled for factors associated with Canadian households' food insecurity in past research, including sex, Aboriginal identity, housing tenure and household type.^{7,25,26} Because regimen complexity has been found to be a key determinant of drug adherence,^{14,27} we further controlled for number of different medications prescribed in the previous year in our models. We tagged missing values with a separate category for the covariates on drug insurance, Aboriginal status, housing tenure and household type. Statistics Canada imputed income for the 11.7% of the sample for whom it was missing; we flagged the imputed income with a dichotomous indicator.

Statistical analysis

We described the sample characteristics with unweighted counts and weighted proportions by medication nonadherence status. We then fitted weighted Poisson regressions on cost-related nonadherence, analyzing the 2 relevant outcomes separately and also collapsing them into a single indicator. Because medication insurance may reduce out-of-pocket drug expenses and increase disposable income for food, we stratified the sample by insurance status and tested whether insurance moderated the association between food insecurity and cost-related nonadherence. We estimated average predicted probabilities (i.e., sample mean of individual probabilities) for those with and without drug insurance, adjusting for

confounders. Last, we restricted the sample to adults who reported cost-related nonadherence and regressed the secondary outcomes on the same set of covariates used in the primary analyses. With the exception of household income, for which Statistics Canada imputed missing values, we did not impute missing values for covariates in our main analyses. However, to ensure the results were not driven by missing values, we experimented with chained multiple imputation for the 750 respondents with missing values for drug insurance, Aboriginal status, housing tenure or household type. We performed all analyses in Stata SE 15.1 (StataCorp), applying 1000-replication bootstrap weights from the Canadian Community Health Survey.

Ethics approval

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

Results

Our analytic sample consisted of 11 172 adults with prescriptions from 8 provinces (Figure 1). Of the 11 172, 737 reported not filling or collecting drug prescriptions or skip-

ping doses because of cost, and 748 reported reducing dosage or delaying filling of prescriptions because of cost. Taken together, 930 respondents (8.3%) reported cost-related nonadherence, of whom 564 reported having drug insurance (Table 1). Compared to adherents, nonadherents were more likely to be female, young, renters, of Aboriginal identity and from lower-income households, and to report no drug insurance (Table 1). Food insecurity was experienced by 10.5% (95% confidence interval [CI] 9.1% to 11.8%) of adherents and 47.9% (95% CI 38.1% to 57.7%) of nonadherents. Cost-related nonadherence was reported by 4.9% (95% CI 4.1% to 5.6%) of food-secure respondents and by 13.2% (95% CI 7.6% to 18.8%), 29.4% (95% CI 23.3% to 35.6%) and 47.1% (95% CI 40.4% to 53.8%) of those from marginally, moderately and severely food-insecure households, respectively. Over half of nonadherents (61.2%, 95% CI 56.0% to 66.3%) could not afford drugs for their chronic conditions, 42.7% (95% CI 38.2% to 47.3%) felt their health condition had worsened as a result of cost-related nonadherence, and 19.7% (95% CI 15.1% to 24.3%) reported greater use of health care services as a result of cost-related nonadherence.

The association between severity of food insecurity and cost-related nonadherence was graded (Table 2, Supplementary Table S2, Appendix 3). After adjustment for sociodemographic confounders, cost-related nonadherence was 1.82 (95% CI 1.00 to 3.31), 3.83 (95% CI 2.44 to 6.03) and 5.05 (95% CI 3.27 to 7.81) times more prevalent among adults from marginally, moderately and severely food-insecure households, respectively, relative to their food-secure counterparts. Translated into predicted probability, the figure was 0.05 (95% CI 0.04 to 0.07) for food-secure adults and 0.10 (95% CI 0.06 to 0.14), 0.20 (95% CI 0.15 to 0.25) and 0.27 (95% CI 0.21 to 0.33) for marginally, moderately and severely food-insecure adults, respectively. Missing values for covariates barely influenced the results: estimates from the multiple imputation yielded prevalence ratios (PRs) of 1.84 (95% CI 1.28 to 2.66), 3.75 (95% CI 2.84 to 4.96) and 4.99 (95% CI 3.79 to 6.58) for marginally, moderately and severely food-insecure adults, respectively. The association with food insecurity was qualitatively the same for not filling prescriptions or skipping doses versus reducing dosage or delaying filling prescriptions except that the former was not associated with marginal food insecurity ($p > 0.1$). The association of food insecurity with cost-related nonadherence was similar for respondents with and without drug insurance; however, the association with marginal food insecurity was significant only among insured respondents (Table 2). Although the probability of nonadherence was mostly lower for insured versus uninsured respondents across food insecurity levels (Figure 2), insurance did not change the correlation between food insecurity and nonadherence (interaction $p > 0.1$ for all).

Among nonadherents, severe food insecurity was associated with higher nonadherence to drugs for chronic conditions (PR 1.42, 95% CI 1.11 to 1.79), as well as perceived health deterioration (PR 1.63, 95% CI 1.18 to 2.24) and increased use of health care services (PR 2.86, 95% CI 1.72 to 4.74) because of cost-related nonadherence (Table 3). Moderate

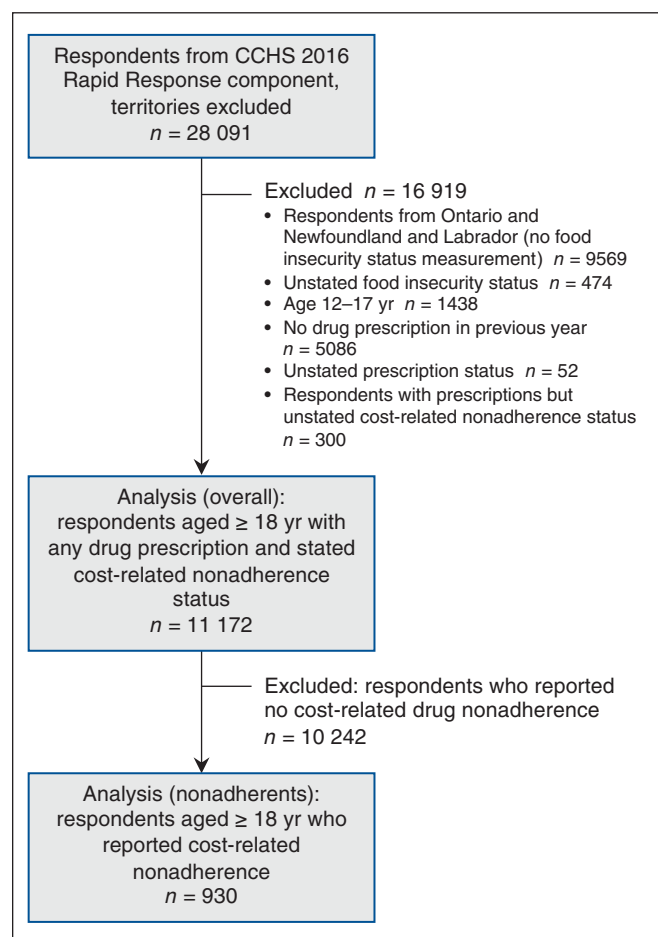


Figure 1: Flow diagram showing sample selection. Note: CCHS = Canadian Community Health Survey.

Table 1: Characteristics of the adult population from the Canadian Community Health Survey 2016 Rapid Response component by cost-related medication nonadherence status

Characteristic	% of population* (95% CI)	
	Adherents n = 10 242†	Nonadherents n = 930†
Household food insecurity		
Food secure	89.5 (88.2 to 90.9)	52.1 (42.3 to 61.9)
Marginally food insecure	3.7 (3.1 to 4.3)	6.4 (3.3 to 9.4)
Moderately food insecure	4.9 (4.3 to 5.6)	23.3 (19.1 to 27.4)
Severely food insecure	1.8 (1.0 to 2.7)	18.3 (12.4 to 24.2)
Any food insecurity	10.5 (9.1 to 11.8)	47.9 (38.1 to 57.7)
Female sex	55.8 (51.4 to 60.3)	65.3 (59.8 to 70.9)
Age quartile (yr)		
1st (18–37)	26.7 (19.9 to 33.6)	44.6 (34.9 to 54.3)
2nd (38–54)	27.0 (21.5 to 32.5)	27.2 (23.0 to 31.3)
3rd (55–67)	26.5 (24.8 to 28.3)	16.4 (11.3 to 21.6)
4th (68–98)	19.7 (8.8 to 30.6)	11.8 (5.1 to 18.5)
Older adults (65–98)	25.7 (12.3 to 39.2)	14.9 (6.4 to 23.5)
Household income quartile (\$‡)		
1st (≤ 37 000)	18.0 (5.9 to 30.2)	30.3 (17.2 to 43.5)
2nd (37 001–69 000)	23.1 (19.0 to 27.2)	30.6 (25.8 to 35.3)
3rd (69 001–118 000)	27.1 (23.1 to 31.0)	23.7 (15.5 to 31.9)
4th (> 118 000)	31.8 (19.5 to 44.2)	15.4 (7.7 to 23.1)
Statistics Canada imputed income	11.5 (10.0 to 13.0)	15.2 (10.1 to 20.4)
Aboriginal status		
Non-Aboriginal	95.7 (95.1 to 96.3)	90.0 (86.6 to 93.5)
Aboriginal	3.9 (3.3 to 4.4)	9.3 (5.9 to 12.8)
Missing	0.4 (0.2 to 0.6)	0.7 (0.1 to 1.2)
Housing tenure		
Renter	24.7 (15.6 to 33.7)	46.2 (38.9 to 53.5)
Homeowner	75.3 (66.2 to 84.3)	53.7 (46.3 to 61.0)
Missing	0.1 (0.0 to 0.1)	0.1 (–0.2 to 0.5)
Household type		
Couple with children	34.7 (14.3 to 55.1)	31.8 (12.5 to 51.0)
Couple without children	35.8 (30.4 to 41.1)	22.1 (15.9 to 28.3)
Lone parents	7.4 (6.3 to 8.4)	14.3 (10.9 to 17.7)
Other	21.8 (–3.5 to 47.1)	30.3 (5.5 to 55.2)
Missing	0.4 (0.1 to 0.7)	1.5 (–0.1 to 3.2)
Province of residence		
British Columbia	19.8 (18.2 to 21.5)	32.5 (27.8 to 37.2)
Alberta	19.0 (16.1 to 21.9)	20.9 (15.1 to 26.7)
Saskatchewan	5.1 (4.6 to 5.6)	4.8 (3.1–6.4)
Manitoba	5.7 (5.3 to 6.0)	6.0 (3.8 to 8.1)
Quebec	40.7 (37.2 to 44.3)	26.2 (19.8 to 32.5)
Atlantic provinces§	9.7 (9.1 to 10.2)	9.7 (6.7 to 12.7)
Prescription drug insurance		
Uninsured	13.8 (12.7 to 14.9)	32.1 (27.7 to 36.4)
Insured	83.6 (81.7 to 85.5)	63.8 (59.6 to 68.0)
Missing	2.6 (1.5 to 3.7)	4.1 (2.4 to 5.9)
No. of medications prescribed		
1	51.4 (43.7 to 59.1)	38.7 (34.2 to 43.2)
2	27.2 (25.0 to 29.3)	31.3 (26.7 to 35.9)
≥ 3	21.4 (15.4 to 27.4)	30.0 (25.5 to 34.5)

Note: CI = confidence interval.

*Weighted by 1000-replication bootstrap weights from the Canadian Community Health Survey 2016.

†Unweighted counts from the sample.

‡Rounded to the nearest \$1000 to protect respondents' identity.

§Prince Edward Island, Nova Scotia and New Brunswick.

Table 2: Adjusted prevalence ratios* of reporting cost-related prescription drug nonadherence in relation to household food insecurity status

Household food insecurity status	Consequence; prevalence ratio (95% CI)				
	Not filling prescription or skipping doses <i>n</i> = 11 178†	Reducing dosage or delaying filling prescription <i>n</i> = 11 466†	Nonadherence		
			Overall sample <i>n</i> = 11 172†	Respondents without insurance <i>n</i> = 1897†	Respondents with insurance <i>n</i> = 8943†
Food secure	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Marginally food insecure	1.48 (0.84 to 2.62)	2.22 (1.14 to 4.35)	1.82 (1.00 to 3.31)	1.20 (0.49 to 2.93)	2.27 (1.24 to 4.14)
Moderately food insecure	3.30 (2.08 to 5.24)	4.58 (2.74 to 7.67)	3.83 (2.44 to 6.03)	3.50 (2.16 to 5.66)	4.27 (2.65 to 6.88)
Severely food insecure	4.77 (3.01 to 7.55)	6.58 (4.02 to 10.77)	5.05 (3.27 to 7.81)	5.18 (3.67 to 7.30)	5.20 (3.24 to 8.34)

Note: CI = confidence interval, ref = reference category.

*From Poisson regression with bootstrapped standard error. All models were adjusted for household income, imputed income, sex, age, Aboriginal status, housing tenure, household type, province, drug insurance status (missing for 332 respondents) and number of different drugs prescribed.

†Unweighted number of observations.

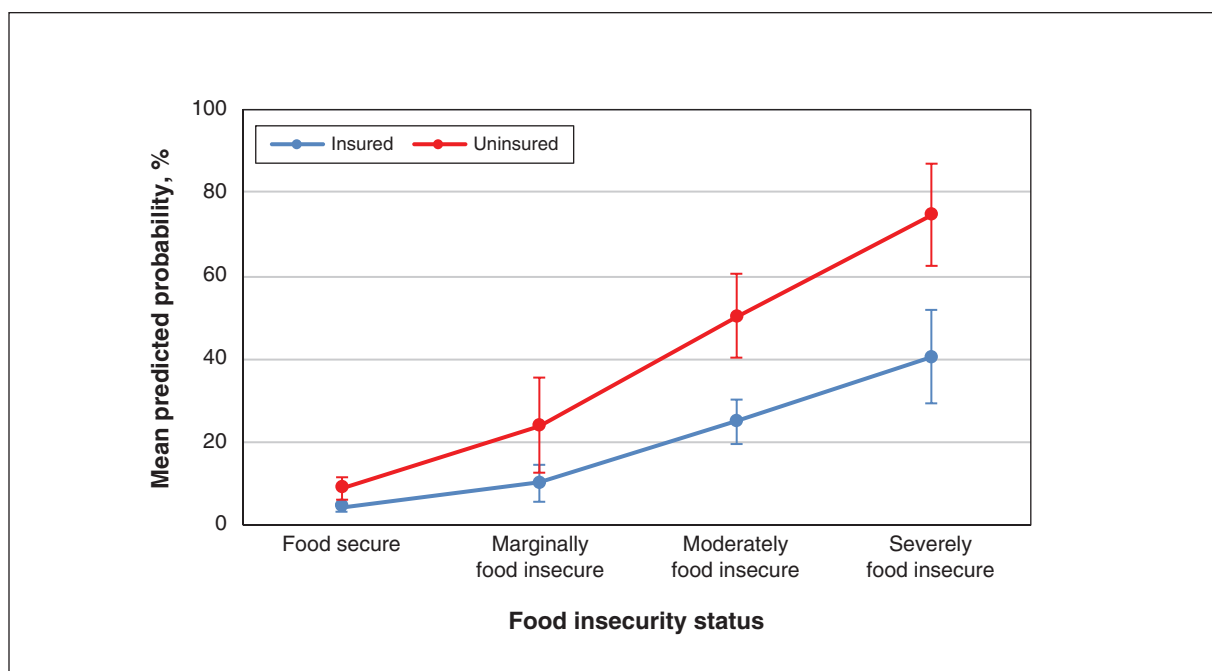


Figure 2: Mean predicted probability of cost-related medication nonadherence (sample mean of individual predicted probabilities) for respondents with and without prescription drug insurance by household food insecurity status; 332 respondents with missing insurance status were excluded from the analysis. Poisson regression with bootstrapped standard error was used, adjusting for household income, imputed income, income source, sex, age, Aboriginal status, housing tenure, household type, province of residence and number of different drugs prescribed. Error bars represent 95% confidence interval.

food insecurity was associated with higher prevalence of cost-related nonadherence to drugs for chronic conditions (PR 1.28, 95% CI 1.07 to 1.53) and worse health owing to unaffordable prescriptions (PR 1.48, 95% CI 1.11 to 1.98) but not greater use of health care services (PR 1.66, 95% CI 0.97 to 2.85). There was no statistically significant association with marginal food insecurity.

Interpretation

Despite the removal of adolescents and 2 provinces from our sample, the prevalence of cost-related nonadherence to prescription drugs was virtually the same as that reported by Law and colleagues⁵ using the same data. Similar to findings from US-based studies,^{16,21,22} after adjustment for confounders, we

Table 3: Adjusted prevalence ratios* of nonadherence for chronic conditions and consequences of cost-related nonadherence in relation to household food insecurity status

Household food insecurity status	Characteristic/consequence; prevalence ratio (95% CI)		
	Nonadherence for chronic conditions <i>n</i> = 902†	Worse health <i>n</i> = 890†	Greater use of health care services <i>n</i> = 909†
Food secure	1.00 (ref)	1.00 (ref)	1.00 (ref)
Marginally food insecure	1.03 (0.75 to 1.40)	1.31 (0.88 to 1.96)	1.65 (0.77 to 3.54)
Moderately food insecure	1.28 (1.07 to 1.53)	1.48 (1.11 to 1.98)	1.66 (0.97 to 2.85)
Severely food insecure	1.42 (1.11 to 1.79)	1.63 (1.18 to 2.24)	2.86 (1.72 to 4.74)

Note: CI = confidence interval, ref = reference.
 *From Poisson regression with bootstrapped standard error. All models were adjusted for household income, imputed income, income source, sex, age, Aboriginal status, housing tenure, household type, province, drug insurance status and number of different drugs prescribed.
 †Unweighted number of observations. Variation is due to the varying number of respondents with missing answers to each of the 3 questions from the Canadian Community Health Survey Rapid Response questionnaire on prescription drug use (PCN_Q030, PCN_Q035 and PCN_Q040) (see Appendix 1).

documented among Canadian adults substantial overlap between food insecurity and cost-related nonadherence and a graded association between the two. Having drug insurance lowered the probability of cost-related nonadherence, but the persisting association between food insecurity and nonadherence among insured adults suggests that the cost-sharing structure of existing insurance plans may pose financial barriers to drug adherence, particularly for food-insecure households. Our findings further suggest that cost-related nonadherence may be on the pathway connecting food insecurity to poor health. Our observation that adults experiencing severe food insecurity tended to report nonadherence to drugs for chronic conditions was consistent with evidence of poorer disease management among food-insecure adults.⁷⁻¹⁰ Medication nonadherence has been associated with heightened risk of hospital admission and death among patients with diabetes.²⁸ The associations we found between food insecurity and worsening health and increased use of health care services are also consistent with prior work linking food insecurity to adverse health outcomes.¹¹⁻¹³ The concurrence of food insecurity with cost-related nonadherence can only compound the health ramifications of either factor alone.

Both food insecurity and cost-related nonadherence are a function of limited resources; accordingly, policies that increase disposable income may help mitigate both issues. In the US, participation in the public health insurance program (Medicaid) and public nutrition program (Supplemental Nutrition Assistance Program) has been associated with less cost-related nonadherence and food insecurity,^{16,29,30} likely by freeing up disposable income as out-of-pocket expenses on health care or food were lowered. In Canada, studies have shown reductions in food insecurity following policy interventions that increased income for low-income households.³¹⁻³⁴

Reducing out-of-pocket drug expenses is another way to improve adherence. Our results lend support to calls for a national pharmacare program, which could potentially reduce prevalence of cost-related nonadherence by providing universal prescription insurance.³⁵⁻³⁷ However, as suggested by our finding that 564 (6.3%) of the 8943 insured adults in our sample reported cost-related nonadherence, the extent to which insurance mitigates cost-related nonadherence depends on the out-of-pocket expenditures required. The dose-response relation between food insecurity and cost-related nonadherence that we found suggests the need for greater reduction — even exemption — of out-of-pocket drug expenses among those experiencing more severe food insecurity. Copayment exemption in private drug insurance was found to reduce cost-related nonadherence in a US sample.³⁸ Lowering or waiving the out-of-pocket expenses for prescriptions may help reduce nonadherence for those with and without insurance in Canada, especially among food-insecure households, with potential positive impact on public health and the health care system.³⁹

Limitations

Our cost-related nonadherence outcome was conditional on having a prescription, which may be subject to negative selection of patients avoiding physician encounters for reasons related to food insecurity. For instance, people with no prescription drug insurance are less likely to visit doctors than their insured counterparts, especially if they have chronic conditions.⁴⁰ This may result from expectation of unaffordable prescriptions and associated shame.⁴⁰ In that respect, our estimates should be regarded as conservative. Also, our survey data were cross-sectional, which limited our ability to ascertain causality. Unobserved factors such as

income instability may have simultaneously driven food insecurity, cost-related nonadherence and poor health. Moreover, our data did not distinguish prescriptions for essential drugs of therapeutic importance from nonessential ones primarily for symptom alleviation.¹⁴ Adherence to nonessential drugs is more sensitive to price changes than adherence to essential drugs but is less impactful on one's health.⁴¹ Future endeavours may compare adherence to different types of drugs in relation to food insecurity to better understand vulnerable households' coping strategies. In addition, cost-related nonadherence was never assessed in the territories, and we had to exclude Ontario and Newfoundland and Labrador because of their failure to measure food insecurity. Our findings may not apply to these missing jurisdictions. Last, our outcomes were all self-reported and, thus, subject to response bias, and covariates such as insurance were also likely underreported.⁴² Since decisions around drug adherence are usually simultaneously driven by multiple factors,^{14,15} some respondents may have downplayed the importance of cost because of social undesirability. We therefore regard our estimates as an underestimate.

Conclusion

We found household food insecurity to be positively associated with cost-related medication nonadherence. We also found increases in self-perceived health impacts of cost-related nonadherence among severely food-insecure non-adherers. Policies that increase disposable income for low-resourced households may attenuate cost-related nonadherence and food insecurity simultaneously. Expanding insurance coverage and adopting a more progressive insurance cost-sharing structure may reduce out-of-pocket prescription costs and associated nonadherence. The linkage between out-of-pocket drug expense and food insecurity needs further investigation, but lower out-of-pocket spending on prescriptions would likely reduce the health burden of food insecurity by fostering medication adherence and disease management.

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