Maternal Food Insecurity is Positively Associated with Postpartum Mental Disorders in Ontario, Canada

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ABSTRACT

Background: Household food insecurity has been associated with pregnancy complications and poorer birth outcomes in the United States and with maternal mental disorders in the United Kingdom, but there has been little investigation of the effects of food insecurity during this life stage in Canada.

Objectives: Our objective was to examine the relationship between the food insecurity status of women during pregnancy and maternal and birth outcomes and health in infancy in Canada.

Methods: We drew on data from 1998 women in Ontario, Canada, whose food insecurity was assessed using the Household Food Security Survey Module on the Canadian Community Health Survey, cycles 2005 to 2011–2012. These records were linked to multiple health administrative databases to identify indications of adverse health outcomes during pregnancy, at birth, and during children's first year of life. We included women who gave birth between 9 months prior and 6 months after their interview date, and for whom infant outcome data were available. Multivariable Poisson regression models were used to compare outcomes by maternal food security status, expressed as adjusted relative risks (aRR) with 95% CIs.

Results: While pregnant, 5.6% of women were marginally food insecure and 10.0% were moderately or severely food insecure. Food insecurity was unrelated to pregnancy complications and adverse birth outcomes, but 26.8% of women with moderate or severe food insecurity had treatment for postpartum mental disorders in the 6-month postpartum period, compared to 13.9% of food-secure women (aRR, 1.86; 95% CI, 1.40–2.46). Children born to food-insecure mothers were at elevated risk of being treated in an emergency department in the first year of life (aRR, 1.18; 95% CI, 1.01–1.38).

Conclusions: Maternal food insecurity during pregnancy in Ontario, Canada, is associated with postpartum mental disorders and a greater likelihood of infants being treated in an emergency department. *J Nutr* 2020;150:3033–3040.

Keywords: food insecurity, mental disorders, infants, pregnancy, Canada

Introduction

Household food insecurity—the inadequate or insecure access to food due to financial constraints—is a serious public health concern in high-income countries. It is also a problem that disproportionately affects households with children (1, 2). In Canada, 12.7% of households experienced marginal, moderate, or severe food insecurity in 2017–18, but the prevalence was higher (16.2%) among households with a child under 18 years of age (3). While there has been considerable research in Canada to examine the relationships between household food insecurity and adults' health and health-care costs, the implications of food insecurity for maternal and infant health have received less attention. Yet, household food insecurity has been associated with significantly poorer dietary intakes among women of childbearing age in Canada (4, 5), potentially predisposing food-insecure women who become pregnant to higher risks of poor birth outcomes. Additionally, food insecurity among women in Canada has been associated with higher rates of perceived stress and social isolation (6), cost-related nonadherence to prescription medications (7), and higher rates of depression and depressive symptoms (6, 8, 9). Given that pregnancy and childbirth place additional pressures on women's mental health and their resources, women who are food insecure at this critical life stage may be at increased risk of complications during pregnancy, adverse birth outcomes, and mental illness postpartum (10, 11).

In the United States, food insecurity in households with children has been associated with increased risks of pregnancy complications (12), hospitalization following discharge after

birth ([13]), and adverse birth outcomes ([14–16]). Additionally, findings from a cohort study from the United Kingdom recently suggested that food insecurity during pregnancy increases the risk of common mental disorders ([17]). Extrapolations to the Canadian context are limited, however, given between-country differences in health-care systems and the presence of large-scale government interventions for at-risk families in the United States, including the Supplemental Nutrition Assistance Program (SNAP) and the Special Supplemental Nutrition Program for Women, Infants, and Children. No similar nutrition interventions exist on this scale in Canada, a country for which there is very little data on the effects of food insecurity on maternal and infant health. In Canada, apart from studies of the relationship between household food insecurity and infant feeding practices ([18–20]), the only insight into the effects of food insecurity on health in early life comes from an ecological study in the province of Quebec, which documented higher rates of small-for-gestational-age births in areas with higher rates of food insecurity ([21]).

Drawing on linked survey and administrative health-care data from a population-based sample of women living in the province of Ontario, we aimed to examine the relationship between the food insecurity status of women during pregnancy and maternal and birth outcomes and health in infancy.

Methods

Data sources and sample

The Canadian Community Health Survey (CCHS) is a cross-sectional survey of approximately 130,000 respondents per cycle. It is designed to be representative of 98% of the Canadian population aged 12 years and over, omitting individuals living on First Nation reserves, in institutions, in the Canadian Armed forces, and in some remote areas in Quebec. Since 2005, household food insecurity over the past year has been assessed on this survey using an adapted version of the 18-item Household Food Security Survey Module, developed by the US Department of Agriculture ([22]). The questions in this module range in severity from experiences of anxiety that food will run out before household members have money to buy more, to skipping or cutting the size of meals, to being hungry without eating, and, in the extreme, going whole days without eating, all because of a lack of money for food. Of the 18 items, 10 questions refer to the experiences of adults and 8 refer

specifically to the experiences of any children under 18 years of age in the household.

This study drew on data from a linked data set comprising all respondents to CCHS cycles 2005, 2007–2008, 2009–2010, and 2011–2012 who were living in the province of Ontario and who, when surveyed, agreed to allow their responses to be linked to health administrative data for research purposes. These are the years for which standardized food insecurity measurements are available on CCHS and the survey data have been linked to Ontario provincial health administrative data. The data sets were linked using unique, encoded identifiers and were analyzed at the Institute for Clinical and Evaluative Sciences. Approximately 83% of women respondents to these survey cycles consented to this linkage. Delivery/birth information for them was identified using deterministically linked hospital discharge records of the mother and the newborn from the Canadian Institute for Health Information Discharge Abstract Database ([23]).

We included women living in Ontario who responded to any of the 4 linked cycles of the survey, had a valid Ontario Health Insurance Plan number, and delivered a live infant between 9 months prior and 6 months after the interview date. This time window was selected to ensure that the 12-month measurement of household food insecurity administered at the time of the interview would encompass at least 1 trimester of pregnancy. We excluded women with multiple pregnancies, those with missing responses to the food security module, and those with missing information on education or home ownership. The final analytic sample comprised 1988 women with infants who were followed to their first birthday.

Food insecurity measurement and classification

Maternal food insecurity status was determined from the 10-item adult subscale in the food security module. Using this subscale ensured comparability in the determination of food insecurity among women with and without children at the time of the interview. Applying the classification scheme developed by Health Canada ([22]), women with 2 or more affirmative responses were considered to be moderately or severely food insecure, referred to here as "food insecure." Women with a single affirmative response were considered marginally food insecure, given prior research indicating the vulnerability of women and children in households that report any indication of food insecurity on this module ([8], [12], [24–29]). Health Canada's definition is more inclusive than that of the US Department of Agriculture, which requires 3 or more affirmative responses on the scale to classify a household as food insecure ([30]). In addition, the term "marginal food insecurity" that is used in Canada is generally called "marginal food security" in the United States.

Health outcome measurements and classifications

We used the Canadian Institute for Health Information Discharge Abstract Database, Ontario Health Insurance Plan claims, Ontario Mental Health Reporting System, and National Ambulatory Care Reporting System to identify indications of illness and adverse health outcomes during pregnancy, at birth, and during the infant's first year of life. The outcomes derived from these administrative databases are based on standardized, diagnostic coding that accompanies physician billings and emergency department or hospital discharge. Maternal health outcomes included admission to hospital during pregnancy, gestational hypertension or diabetes, and postpartum mental disorders. The latter variable described women who had been seen by a primary care physician or psychiatrist or had been hospitalized or treated in an emergency department for depression or other diagnosed mental health problems in the year following delivery. Birth outcomes of interest included birth before 37 completed gestation weeks, admission to a neonatal intensive care unit for congenital anomalies, being small for gestational age, and being large for gestational age, based on a Canadian population-based reference ([31]). Infant health outcomes included hospitalization and emergency department visits during the first year of life. The administrative health-care databases and diagnostic codes used are detailed in **Supplemental Table 1**.

Analyses

We compared sociodemographic characteristics and outcome rates among food-secure, marginally food-insecure, and food-insecure groups. All univariable descriptive analyses were performed using the Kruskal-Wallis test for continuous variables and chi-square tests for categorical variables.

Multivariable Poisson regression models with robust standard errors (32) were used to estimate the adjusted relative risks (aRR) for each binary outcome, with 95% CIs, comparing women with versus without food insecurity. The mean length of stay in hospital for childbirth was compared between groups using linear regression. Models were adjusted for factors associated with food insecurity and health outcomes that could confound the relationship between these variables. These included the woman's age group (<20, 20–24, 25–34, or ≥35 y), partnership status (partnered or not partnered), history of a previous live birth (yes/no), housing tenure (own or rent dwelling), residence (urban or rural), main source of household income (wages, social assistance, or other), immigration status (Canadian born or not stated versus immigrant), race (White or non-White), and education level (less than secondary school graduation, secondary school graduate, some post-secondary schooling, or post-secondary school graduate) (28, 33–35). Given other research suggesting that maternal depression can impact the relationship between food insecurity and children's health (36–39), we also ran the multivariable analyses of infant health outcomes, including postpartum mental disorders in the 12 months following birth (yes/no) and any health-care utilization for mental health reasons in the 12 months prior to the birth (yes/no) as covariates (40). Additionally, we reran the multivariable analysis of food insecurity in relation to postpartum mental disorders, adjusted for any health-care utilization for mental health reasons in the 12 months prior to the birth (yes/no).

Statistical significance was determined as a 2-tailed *P* value < 0.05. Analyses were performed using SAS version 9.4 (SAS Institute, Inc.). Ethics approval for this study was obtained from the Health Sciences Research Ethics Board at the University of Toronto.

Results

The sociodemographic characteristics of the sample, by household food insecurity status, are presented in **Table 1**. While pregnant, 5.6% of women were marginally food insecure and 10.0% were food insecure. Compared to the food secure, food-insecure and marginally food-insecure women tended to be younger, to be less well educated, and to rent rather than own their dwelling. A significantly higher proportion of food-insecure women did not have a partner and were reliant on income sources other than employment.

Pregnancy and maternal health

Although there was little difference in rates of hospitalization during pregnancy and gestational hypertension or diabetes by food insecurity status, the prevalence of postpartum mental disorders was higher among food-insecure women (34.8% versus 15.2% among marginally food-insecure women and 20.6% among the food secure; **Table 2**).

In multivariable analyses, maternal food insecurity was not associated with hospitalization during pregnancy, length of stay in hospital for childbirth, or the risk of complications due to gestational hypertension or diabetes (**Table 3**). Compared to food-secure women, food-insecure women had elevated risks of being treated for postpartum mental disorders in the first 6 months following delivery (aRR, 1.86; 95% CI, 1.40–2.46) and in the subsequent 6 months (aRR, 1.38; 95% CI, 1.00–1.90; **Table 3**). When health-care utilization for mental health reasons in the 12 months prior to the birth was taken into account, only the risk of food-insecure women being treated for postpartum mental disorders in the first 6 months remained

significantly elevated (aRR, 1.61; 95% CI, 1.21–2.13; **Table 4**). No difference in risk was observed between marginally food-insecure and food-secure women.

Birth outcomes and health in infancy

There were no significant differences in the risks of a preterm birth, congenital anomalies, or infants who were small or large for gestational age by food insecurity status (**Table 3**). Similarly, maternal food insecurity was unrelated to the risk of infants being admitted to a neonatal intensive care unit.

The risk of being hospitalized in the first year of life did not differ by maternal food insecurity status, once maternal and household sociodemographic characteristics were taken into account (**Table 3**). Children born to food-insecure mothers were at elevated risk of being treated in an emergency department in the first year of life (aRR, 1.18; 95% CI, 1.01–1.38). This association was similar upon adjustment for the mother's prior history of treatment for mental health reasons (aRR, 1.17; 95% CI, 1.00–1.36; **Table 4**). There was no relationship between marginal food insecurity and emergency department visits (**Table 3**).

Discussion

In a population-based sample of women in the Canadian province of Ontario (2005 to 2012), those who reported moderate or severe food insecurity while pregnant were more likely than other women to be treated for postpartum mental disorders. However, maternal food insecurity was not associated with complications during pregnancy or adverse birth outcomes. Children born to moderately or severely food-insecure mothers were at greater risk of being treated in an emergency department during infancy. After accounting for confounding factors, marginal food insecurity was not associated with the risk of maternal or infant health outcomes.

Our finding of an increased risk of postpartum mental disorders among food-insecure women is consistent with research in the United Kingdom (17), and with the much broader body of literature linking food insecurity to mental illness in Canada (6, 8, 9, 40) and the United States (38, 41–44). Our results also add to prior research charting the elevated health-care utilization among food-insecure adults in Ontario (5, 40, 45), suggesting that household food insecurity is linked to health and health-care utilization postpartum and in infancy.

Although research in the United States has documented significant associations between food insecurity and pregnancy complications (12), hospitalization following discharge after birth (13), and adverse birth outcomes (14–16), we did not find evidence of similar associations in this Canadian sample. The absence of differences in preterm births and the prevalence of infants who were small or large for their gestational age could perhaps in part be attributable to the supports available to vulnerable pregnant women through the Canada Prenatal Nutrition Program (CPNP) (46). This federal program was launched with the explicit goal of increasing the number of babies born with healthy birth weights. Delivered in partnership with the provinces and territories, CPNP funds community programs to deliver a range of services and supports, including some food and nutrition supplements, to at-risk women. A 2012 evaluation indicated better birth outcomes among program participants (47), but no population data on participation rates or program impacts among women in food-insecure

TABLE 1 Sociodemographic characteristics of the sample, by household food insecurity status

Characteristic	Total, $n = 1988$	Food secure,[1] $n = 1678$	Marginal insecurity,[2] $n = 112$	Moderate or severe insecurity,[3] $n = 198$	P value[4]
Age at the index delivery, y					
Mean ± SD	29.59 ± 5.38	29.96 ± 5.20	27.75 ± 5.80	27.46 ± 5.94	<0.001
Median [IQR]	30 [26–33]	30 [27–34]	27 [24–32]	27 [23–31]	<0.001
Age at the index delivery, n (%)	—	—	—	—	<0.001
<20 y	75 (3.8)	50 (3.0)	12 (10.7)	13 (6.6)	
20–24 y	279 (14.0)	194 (11.6)	21 (18.8)	64 (32.3)	
25–29 y	621 (31.2)	530 (31.6)	39 (34.8)	52 (26.3)	
30–34 y	649 (32.6)	579 (34.5)	29 (25.9)	41 (20.7)	
≥35 y	364 (18.3)	325 (19.4)	11 (9.8)	28 (14.1)	
Previous live birth	—	—	—	—	0.16
None	937 (47.1)	806 (48.0)	49 (43.8)	82 (41.4)	
≥1	1051 (52.9)	872 (52.0)	63 (56.3)	116 (58.6)	
Educational attainment, n (%)	—	—	—	—	<0.001
<Secondary school graduation	172 (8.7)	119 (7.1)	17 (15.2)	36 (18.2)	
Secondary graduate	297 (14.9)	232 (13.8)	21 (18.8)	44 (22.2)	
Some post–secondary school	112 (5.6)	79 (4.7)	10 (8.9)	23 (11.6)	
Post–secondary school graduate	1407 (70.8)	1248 (74.4)	64 (57.1)	95 (48.0)	
Number of children <18 y in household					
Mean ± SD	1.40 ± 1.05	1.36 ± 1.03	1.46 ± 1.08	1.70 ± 1.19	<0.001
Median [IQR]	1 [1–2]	1 [1–2]	1 [1–2]	2 [1–2]	<0.001
Partnership status, n (%)	—	—	—	—	<0.001
Married or common law	1714 (86.2)	1502 (89.5)	86 (76.8)	126 (63.6)	
Single, divorced, separated, or widowed	274 (13.8)	176 (10.5)	26 (23.2)	72 (36.4)	
White, n (%)	—	—	—	—	<0.001
No	410 (20.6)	320 (19.1)	32 (28.6)	58 (29.3)	
Yes	1578 (79.4)	1358 (80.9)	80 (71.4)	140 (70.7)	
Immigrant status, n (%)	—	—	—	—	0.20
Non-immigrant or not stated	1587 (79.8)	1346 (80.2)	82 (73.2)	159 (80.3)	
Immigrant	401 (20.2)	332 (19.8)	30 (26.8)	39 (19.7)	
Main source of household income, n (%)	—	—	—	—	<0.001
Wages, salaries, self-employment	1768 (88.9)	1554 (92.6)	92 (82.1)	122 (61.6)	
Social assistance	92 (4.6)	44 (2.6)	7 (6.3)	41 (20.7)	
Other	128 (6.4)	80 (4.8)	13 (11.6)	35 (17.7)	
Housing tenure, n (%)	—	—	—	—	<0.001
Owner	1402 (70.5)	1282 (76.4)	59 (52.7)	61 (30.8)	
Renter	586 (29.5)	396 (23.6)	53 (47.3)	137 (69.2)	
Rural residence, n (%)	—	—	—	—	0.17
Urban	1575 (79.2)	1319 (78.6)	89 (79.5)	167 (84.3)	
Rural	413 (20.8)	359 (21.4)	23 (20.5)	31 (15.7)	
Any health-care utilization for mental health reasons in the 12 mo prior to the index birth, n (%)	—	—	—	—	<0.001
Yes	326 (16.4)	254 (15.1)	16 (14.3)	56 (28.3)	
No	1662 (83.6)	1424 (84.9)	96 (85.7)	142 (71.7)	

Values are mean ± SD, median [IQR], or frequency (%).
[1] No affirmative response on the 10-item adult subscale of the Household Food Security Survey Module.
[2] 1 affirmative response to the 10-item adult subscale of the Household Food Security Survey Module.
[3] ≥2 affirmative responses to the 10-item adult subscale of the Household Food Security Survey Module.
[4] P values were derived from the Kruskal-Wallis test for continuous variables and chi-square tests for categorical variables.

households are available. Without information on CPNP program participation among the women in our sample, it is impossible to determine whether this program affected their birth outcomes.

Although we did not find higher rates of pregnancy complications or birth outcomes among food-insecure women, this group had marked differences in their mental health, which may relate to the particular nature of the publicly funded Canadian health-care system. This system appears to mitigate socioeconomic disparities in access to physical health care to a greater extent than mental health services (35). Although the mental health care provided by primary care physicians and psychiatrists is fully funded, care by clinical psychologists or other nonphysician providers is generally not funded by the public system. We speculate that food-insecure women may be more likely to experience prolonged or untreated mental health challenges due to their reduced access to services and social supports that are not publicly funded; as a result, they may be at increased risk of eventually meeting the physician-ascertained outcomes that were measured in this study (i.e., assessment or treatment by psychiatrist; emergency department visit for a mental health issue).

TABLE 2 Maternal, birth, and infant health outcome rates, by food insecurity status

Characteristic	Total	Food secure	Marginal insecurity	Moderate or severe insecurity	P value[1]
Maternal outcomes					
Admission to hospital during pregnancy, n (%)	135 (6.8)	109 (6.5)	9 (8.0)	17 (8.6)	0.47
Length of stay in hospital for childbirth episode, d, mean ± SD	2.32 ± 1.58	2.31 ± 1.61	2.24 ± 1.01	2.38 ± 1.59	0.73
Pregnancy complication: hypertension or diabetes, n (%)	157 (7.9)	130 (7.7)	8 (7.1)	19 (9.6)	0.63
Postpartum mental disorders					
1–179 d after the index delivery, n (%)	297 (14.9)	234 (13.9)	10 (8.9)	53 (26.8)	<0.001
180–364 d after the index delivery, n (%)	267 (13.4)	215 (12.8)	10 (8.9)	42 (21.2)	0.002
0–364 d after the index delivery, n (%)	431 (21.7)	345 (20.6)	17 (15.2)	69 (34.8)	<0.001
Birth outcomes					
Newborn with clinical gestation <37 wk, n (%)	107 (5.4)	89 (5.3)	6 (5.4)	12 (6.1)	0.91
Admission to neonatal intensive care unit, n (%)	231 (11.6)	193 (11.5)	10 (8.9)	28 (14.1)	0.36
Small for gestational age, n (%)	152 (7.6)	131 (7.8)	6 (5.4)	15 (7.6)	0.64
Large for gestational age, n (%)	245 (12.3)	205 (12.2)	14 (12.5)	26 (13.1)	0.93
Congenital anomalies, n (%)	91 (4.6)	73 (4.4)	9 (8.0)	9 (4.5)	0.20
Infant outcomes					
At least 1 hospital admission in first year of life, n (%)	166 (8.4)	132 (7.9)	10 (8.9)	24 (12.1)	0.12
At least 1 emergency department visit in first year of life, n (%)	877 (44.1)	708 (42.2)	59 (52.7)	110 (55.6)	<0.001

Values are mean ± SD, median [IQR], or frequency (%).
[1] P values were derived from the chi-square test for categorical variables and Kruskal-Wallis test for continuous variable.

Strengths of this study include our use of a population-based sample, with a standardized, well-validated measure of food insecurity and objective measures of health and health-care use based on physician diagnoses and administrative data on hospitalizations and emergency department visits in a universal health-care system. Our study pooled data for women in Ontario from 2005 to 2012: a period when the provincial prevalence of moderate/severe household food insecurity ranged from 7.7% to 9.2% (48). The provincial prevalence has remained relatively stable since then, with 9.0% of households in Ontario classified as moderately or severely food insecure in 2017–18 (3). Although there are regional and socioeconomic differences in health-care access in Ontario (34), such biases are likely to lessen the probability of food-insecure mothers using the health-care system, thus dampening our ability to see associations between maternal food insecurity and the health outcomes considered here. Our study may also have been affected by nonresponse bias. Although 83% of women living in Ontario who participated in the CCHS agreed to have their data linked to their health records, the representativeness of the sample cannot be ascertained from the available data.

TABLE 3 Associations between food insecurity status and maternal, birth, and infant health outcomes

Characteristic	Marginal food insecurity		Moderate/severe food insecurity	
	Crude RR[1] (95% CI)	Adjusted RR[2] (95% CI)	Crude RR[1] (95% CI)	Adjusted RR[2] (95% CI)
Maternal outcomes				
Admission to hospital during pregnancy	1.24 (0.64–2.38)	1.09 (0.57–2.09)	1.32 (0.81–2.16)	0.94 (0.55–1.60)
Mean length of stay in hospital for childbirth episode, d	0.97 (0.86–1.09)[3]	1.00 (0.89–1.11)[4]	1.03 (0.95–1.12)[3]	1.03 (0.94–1.13)[4]
Pregnancy complication: hypertension or diabetes	0.92 (0.46–1.83)	0.99 (0.51–1.92)	1.24 (0.78–1.96)	1.44 (0.88–2.35)
Postpartum mental disorders				
1–179 d after the index delivery	0.64 (0.35–1.17)	0.66 (0.36–1.22)	1.92 (1.48–2.49)**	1.86 (1.40–2.46)**
180–364 d after the index delivery	0.70 (0.38–1.28)	0.65 (0.35–1.19)	1.66 (1.23–2.23)**	1.38 (1.00–1.90)*
0–364 d after the index delivery	0.74 (0.47–1.16)	0.72 (0.46–1.13)	1.69 (1.37–2.10)**	1.53 (1.21–1.93)**
Birth outcomes				
Newborn with clinical gestation <37 wk	1.01 (0.45–2.26)	1.03 (0.45–2.35)	1.14 (0.64–2.05)	0.98 (0.51–1.90)
Admission to neonatal intensive care unit	0.78 (0.42–1.42)	0.75 (0.41–1.38)	1.23 (0.85–1.78)	1.09 (0.73–1.62)
Congenital anomalies	1.85 (0.95–3.59)	1.96 (0.99–3.86)	1.04 (0.53–2.06)	1.13 (0.52–2.45)
Small for gestational age	0.69 (0.31–1.52)	0.57 (0.26–1.27)	0.97 (0.58–1.62)	0.80 (0.47–1.37)
Large for gestational age	1.02 (0.62–1.70)	1.13 (0.68–1.87)	1.07 (0.73–1.57)	1.14 (0.75–1.72)
Infant outcomes				
At least 1 hospital admission in first year of life	1.14 (0.61–2.10)	1.08 (0.59–1.95)	1.54 (1.02–2.32)*	1.44 (0.89–2.32)
At least 1 emergency department visit in first year of life	1.25 (1.04–1.50)*	1.17 (0.97–1.40)	1.32 (1.15–1.51)**	1.18 (1.01–1.38)*

*P < 0.05, **P < 0.001.
[1] RRs are reported unless otherwise specified.
[2] Unless otherwise specified, values are RRs derived from Poisson regression analyses, adjusted for age group, partnership status, previous live birth, housing tenure, rural residence, main income source of the household, immigration status, race, and education level.
[3] Mean difference in length of stay (95% CI).
[4] Mean difference in length of stay (95% CI), derived from linear regression model adjusted for age, partnership status, previous live birth, housing tenure, rural residence, main income source of the household, immigration status, race, and education level.

TABLE 4 Associations between food insecurity status and maternal and infant outcomes, adjusting for maternal mental health

Characteristic	Adjusted[1] RRs (95% CI)	
	Marginal food insecurity	Moderate/severe food insecurity
Maternal outcomes, postpartum mental disorders		
1–179 d after the index delivery	0.68 (0.38–1.22)	1.61 (1.21–2.13)**
180–364 d after the index delivery	0.65 (0.37–1.16)	1.18 (0.86–1.63)
0–364 d after the index delivery	0.73 (0.47–1.12)	1.36 (1.07–1.71)*
Infant outcomes		
At least 1 hospital admission in first year of life	1.10 (0.61–2.00)	1.41 (0.87–2.31)
At least 1 emergency department visit in first year of life	1.18 (0.98–1.41)	1.17 (1.00–1.36)
Small for gestational age	0.57 (0.26–1.28)	0.80 (0.47–1.37)
Large for gestational age	1.13 (0.68–1.88)	1.16 (0.77–1.76)

*$P < 0.05$, **$P < 0.01$.

[1]Relative risk (95% CI) derived from Poisson regression models, adjusted for age group, partnership status, previous live birth, housing tenure, rural residence, main income source of the household, immigration status, race, education level, and any health-care utilization by the mother for mental health reasons in the 12 months prior to the birth. Models predicting infant outcomes were additionally adjusted for evidence of postpartum mental disorders in the 12 months following birth.

Our study has 3 limitations that can be addressed in future research. First, although we had data on women's histories of health-care use for mental health problems, we were reliant on a single, cross-sectional assessment of food insecurity and household material resources. Our 12-month measure of food insecurity encompassed at least 1 trimester of pregnancy, but knowing the extent to which food insecurity also occurred over other time periods would advance our understanding of the pathways through which maternal food insecurity influenced the outcomes charted here. Second, missing data for household income in CCHS precluded an adjustment for this variable in our models. Although we included adjustments for housing tenure and main source of household income to capture broad differences in household resources, future Canadian research should aim to differentiate the effects of food insecurity in relation to maternal and infant health from the effects of low income more generally. Third, the low number of women with moderate/severe food insecurity limited our power to assess the relationships between food insecurity and relatively rare birth outcomes. US studies documenting associations between maternal food insecurity and birth defects, preterm births, and low birth weights have been much larger and/or focused on deprived samples (14–16), suggesting that more extensive investigation of these conditions in association with food insecurity is warranted in Canada.

Prior Canadian research has documented food-insecure women's lower likelihood of sustaining exclusive breastfeeding (18, 20) and their struggles to access needed formula (20, 49–51). Our results importantly extend this understanding of vulnerability, revealing the elevated risk of maternal mental disorders and infants' treatment in emergency departments in the context of moderate/severe food insecurity. Although our data on food insecurity in these families were limited to a single 12-month period, food insecurity disproportionately affects families with children in Canada (3), and the sociodemographic characteristics of the women who were food insecure during pregnancy suggest that many are at elevated risk of food insecurity going forward (28). This is particularly concerning in light of US research linking food insecurity to impaired mental health and to development and behavioral problems among young children (36–38, 52–54), and evidence that the combination of maternal depression and food insecurity negatively impacts infant feeding practices, heightening the risk of overweight among toddlers (39). Our study does not furnish proof of a causal relationship between maternal food insecurity

and maternal and infant health, but considering the present findings in the context of the broader body of research on food insecurity and health, it seems reasonable that interventions to reduce food insecurity among families in Canada would lay a better foundation for maternal and child health. Whereas public food and nutrition assistance programs such as SNAP are central to efforts to address food insecurity in the United States (55–57), cash transfer programs define the social safety nets of many other high-income countries, including Canada (58). In Canada, federal and provincial child benefits have been shown to have positive effects on the food security of low-income families (33, 59–61), but the potential of these benefit programs to address family food insecurity is yet to be realized. The prevalence of severe food insecurity among low-income families fell by one-third following the recent introduction of the Canada Child Benefit, but the benefit was not designed to reduce food insecurity, and the overall prevalence of food insecurity among Canadian families remains unchanged (59). However, the analysis suggested that improving the benefit for low-income families would be an effective means to reduce their risk of food insecurity. Our findings highlight the potential to improve maternal mental health and infant health through interventions that reduce food insecurity.

Acknowledgments

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