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Severity of Household Food Insecurity Is Sensitive to Change in Household Income and Employment Status among Low-Income Families[1–3]

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Abstract

Cross-sectional studies have established a relationship between poverty and food insecurity, but little is known about the acute changes within households that lead to changes in food insecurity. This study examined how changes in income, employment status, and receipt of welfare related to change in severity of food insecurity during 1 y among low-income families. In 2005–2007, 501 families living in market and subsidized rental housing were recruited through door-to-door sampling in high-poverty neighborhoods in Toronto. One year later, families were re-interviewed. The final longitudinal analytic sample included 331 families. Within-household change in income, employment, and welfare receipt were examined in relation to change in severity of food insecurity. Severity was denoted by the aggregate raw score on the Household Food Security Survey Module (HFSSM). Analyses were stratified by housing subsidy status owing to differences in characteristics between households. Food insecurity was a persistent problem among families; 68% were food insecure at both interviews. Severity was dynamic, however, as 73.4% answered more or fewer questions affirmatively on the HFFSM between baseline and follow-up. Among market-rent families, a $2000 gain in income during the year and gain of full-time employment were associated with a 0.29 and 1.33 decrease in raw score, respectively ($P < 0.01$). This study suggests that improvements in income and employment are related to improvements in families' experiences of food insecurity, highlighting the potential for income- and employment-based policy interventions to affect the severity of household food insecurity for low-income families. J. Nutr. 143: 1316–1323, 2013.

Introduction

Household food insecurity is increasingly being recognized as a serious public health problem in high-income countries. In Canada, most recent estimates from 2011 show that 12.3% of households experienced a marginal, moderate, or severe level of food insecurity (1). Food insecurity has been associated with higher rates of self-reported poor health and chronic health conditions (2–8) and nutritional vulnerability among adults (9,10) and greater risk of poor health among children (11–14). Importantly, there are indications that health risks are heightened with the level of severity of food insecurity (3,12,15) as well as duration of the experience (16,17). The prevalence of household food insecurity and indications of serious consequences associated with the condition highlight the need for targeted intervention, but there has been little examination of the factors that mitigate the experience of food insecurity among vulnerable households.

Although different measures have been used, cross-sectional, population-based surveys in the United States (18–20), Canada (21–23), the United Kingdom (11,24), and Australia (25) have generated an understanding of the household characteristics associated with food insecurity, namely low household income, lack of home ownership, receiving welfare, and single motherhood. Lack of savings and investments has also been associated with greater odds of food insecurity (20,26). Although these characteristics point to an underlying condition of financial vulnerability and suggest that interventions aimed at increasing income and financial security would improve access to food for food-insecure families, little is known about how changes in income within households relate to amelioration or deterioration of food insecurity. Two studies have examined income changes and availability of liquid assets in the month before food sufficiency status was observed and found that households that experienced negative income shocks in the month preceding measurement were more likely

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to be food insufficient at the end of the period, but these studies did not track a change in status (27,28). Ribar and Hamrick (29) observed characteristics associated with the likelihood of households transitioning in or out of food insufficiency and highlighted that households without asset income and lower income:poverty ratios were more likely to transition into food insufficiency, but they did not examine changes in income in relation to transition into or out of food insufficiency.

Because unmeasured characteristics that make households more susceptible to both food insecurity and financial vulnerability could underlie associations between negative income shocks and low income and assets with risk of becoming food insufficient, examining within-household changes in financial circumstances in relation to changes in food insecurity is important for providing insight into dynamic associations (30). To our knowledge, only one study has examined the dynamic relationship between income changes and employment changes with changes in food sufficiency status (30). In their study population of mothers receiving cash assistance in Michigan, Heflin et al. (30) used a fixed effects model to examine change in food sufficiency status during 5 waves of interviews and observed that changes in household monthly income changes food insufficiency status were inversely related (30).

This study builds on the literature that has highlighted a relationship between income changes and risk of food insufficiency by using the Household Food Security Survey Module (HFSSM) to examine how changes in household income and employment relate to change in raw score on the 18-item scale and, thus, amelioration or deterioration in severity of food insecurity. Our objective was to examine the dynamics of severity of food insecurity from one year to the next among a sample of low-income families in Toronto and determine how changes in available household financial resources related to changes in severity.

Methods

Sample. The data for this analysis come from a study of low-income families in Toronto, Canada, designed to examine relationships of household characteristics, subsidized housing, and neighborhood factors with food insecurity (31–33). Protocols for the baseline and follow-up study were approved by the Human Subjects Research Ethics Board at the University of Toronto. A total of 501 families were recruited into the baseline study population (62% recruitment rate) through door-to-door sampling in high-poverty census tracts in Toronto from November 2005 to January 2007 (**Supplemental Fig. 1**) (31). Eligible families were tenants with at least one child 18 y of age or younger, able to complete an interview in English, and had a gross income at or below the mid-level of Statistics Canada's 5 category income adequacy scale (≤$29,999, $39,999, or $59,999 for households of 1 or 2 people, 3 or 4 people, or ≥5 people, respectively). The original interest in the relationship between housing subsidy and food insecurity meant a quota sampling strategy was used to recruit equal numbers of families living in subsidized housing and market-rent housing. A structured oral interview was conducted with the household member primarily in charge of household food shopping and management.

Of the 501 families recruited at baseline, 384 families were contacted and re-interviewed approximately 1 y after the baseline interview (Supplemental Fig. 1). Thus, 117 families (23%) were lost to follow-up or declined to participate in a second interview. Baseline household characteristics associated with odds of completing a follow-up interview were examined by multivariate logistic regression in samples stratified by housing subsidy receipt. Baseline household characteristics were not predictive of completion of the follow-up interview among market rent households, but among subsidized rent families, severe food insecurity and lack of employment at baseline were associated with higher odds of completing the follow-up study visit.

In addition to families lost to follow-up, 13 families were excluded from the longitudinal analytic sample, because closer examination of their baseline incomes deemed them ineligible according to the original criteria. Due to the potential for intra-household variability in reporting of food insecurity (34), we also excluded 17 families from the follow-up sample, because a different representative from the household was interviewed at follow-up than at baseline. Comparison between baseline and follow-up data led to the further exclusion of 23 families due to missing information for key variables of interest between baseline and follow-up that compromised classification of change within a household (e.g., not all HFSSM questions answered, income missing from some sources). A total of 331 families were included in the final longitudinal analytic sample used in this study. In a sensitivity analysis, the main analytic models were run using all households that returned at follow-up. Results were attenuated but remained significant. We report the results for the analytic longitudinal sample of 331 families, because these results were less biased by random error in the outcome and predictor variables.

Outcome variable. The survey questionnaire included the HFSSM used by Health Canada (35), modified to include only 17 of the 18 items due to concern held by a research partner that report of a child ever having gone a whole day without eating may warrant report to child welfare authorities. For descriptive purposes, a household was classified as food insecure if any questions were answered affirmatively on the HFSSM scale in alignment with current thinking about the vulnerability of marginally food-insecure households (36,37). Severe food insecurity was defined according to Health Canada's classification schema, which considers the number of affirmatives on the child and adult scales separately (35). To examine changes in severity of food insecurity, the raw score on the HFSSM (i.e., aggregate number of affirmative responses) was used as a continuous variable ranging from 0 to 17.

Predictor variables. Predictor variables of interest focused on those related to available financial resources as reflected by household income, employment, and receipt of welfare. These variables reflect income flow into the household as well as access to credit and assets. Specifically, new receipt of welfare is indicative of low liquid assets, owing to entry rules that require applicants to divest themselves of liquid assets to qualifying levels (e.g., Ontario liquid asset exemption level for lone parent and one child family in 2006 was $1487.00) (38). Loss or gain of employment was predicted to be associated with changes in food insecurity independent of changes in income, because it could alter access to credit and other financial benefits such as prescription drug insurance.

Information on household income during the past 12 mo from all contributing household members and sources was collected and adjusted for household size using the Organization for Economic Co-operation and Development-modified scale to account for differences in consumption of household resources (39); thus, this variable implicitly controls for changes in household composition, though few households experienced changes in household size over the follow-up period.

Respondents were asked to report all employment currently held by household members at the time of the survey and asked to specify whether the position was part-time or full-time (defined as ≥30 h/wk). The number of adults with full-time employment was considered separately from number with part-time employment, as it was hypothesized that a stronger relationship would be observed for full-time employment because it would more likely include additional benefits beyond income. Receipt of welfare was made into a dichotomized variable denoted by 1 vs. 0 for households that reported welfare income at any time in the past 12 mo compared with households that did not receive any welfare income.

Statistical analysis. All analyses were carried out using SAS 9.2 (SAS Institute) and values were considered significant at $P \leq 0.05$.

Subsidized and market-rent families were expected to differ with respect to a number of household characteristics due to an a priori hypothesis that families living in subsidized housing would have more vulnerable status, because this housing program gives priority to victims of domestic abuse, homeless individuals, and families whose members are separated due to a lack of housing. Additionally, given the dynamic relationship between income and rent for subsidized housing families

(i.e., tenants pay 30% of their income in rent, with rent amounts fluctuating throughout the year relative to income fluctuations), changes in household finances were not anticipated to have the same effect for subsidized and nonsubsidized families. To test these hypotheses, differences in household characteristics by housing subsidy status were tested by chi-square test of proportions for categorical variables and *t* tests for continuous variables. Second, the interaction between change in income and subsidy status was tested in an initial regression model and approached significance ($P = 0.08$); thus, regression analyses were stratified by housing subsidy receipt.

The primary analysis was an examination of how change in predictor variables of interest related to change in severity food insecurity as measured by a change in raw score on the HFSSM between baseline and follow-up interviews. The analysis followed the method for a fixed-effect analysis for a 2-period case shown by Allison (40) using difference scores and PROC REG. In this model, time-invariant characteristics are implicitly controlled for. The model tested whether within-household change in severity of food insecurity was related to within-household changes in Organization for Economic Co-operation and Development-adjusted income, number of adults with full-time employment, number of adults with part-time employment, and receipt of welfare payments. To account for the truncated nature of the continuous severity variable (i.e., 0 affirmatives and 17 affirmatives), dummy variables were included in the model to denote if a household answered zero questions affirmatively at baseline and if a household answered 17 questions affirmatively at baseline. This was necessary because if households with a score of 0 experienced improvements in predictor variables, no change in severity would be reflected in number of affirmatives, because they already had scores at the minimum. Similarly, deterioration in predictor variables could not result in a worsening score for households who answered the maximum number of questions affirmatively at baseline.

Information on household expenses in the past 12 mo was not collected at either interview, nor was direct information on access to credit, household savings, or other financial benefits tied to employment; thus, these variables were not included in models. The selection of a fixed-effect model means that unchanging household expenses and access to credit and assets were intrinsically adjusted for, but the impact of a change in these variables within a household could not be accounted for. Similarly, a potential buffering effect of having access to savings, credit, or unemployment insurance on impact of job and income losses could not be tested.

Subsequent to these analyses, baseline household characteristics were examined in relation to change in income and gains in employment to examine if there was a patterning of propensity to have experienced change in the study population. The former involved a multivariate regression analysis to examine the change in household income by household characteristics. The latter were logistic regression analyses for gain of full-time work and gain of part-time work.

Sensitivity analyses. Although use of the continuous raw score on the HFSSM allows for change in severity of food insecurity to be observed, in using the continuous variable, 2 major issues arise: *1*) the raw score is not linear at the extreme ends of the scale (41); and *2*) the truncated nature of the scale means restricted movement in change values for households close to the thresholds. Inclusion of dummy variables denoting households with minimal and maximal scores at baseline only partially accounted for these problems. To account for these limitations, in a series of sensitivity analyses, households with no affirmative responses were coded at different interval distances to test the robustness of the linear regression findings (i.e., were given values of -1, -2, -3, -4, -5, or -6 in different models). This meant that the difference scores for households that crossed the 0/1 threshold (specifically, 34 market-rent households and 26 subsidized-rent households) were allowed to be greater relative to the one-unit changes for households on the scale. Results were robust across the successive models. Increasing the interval improved model fit and increased the magnitude of coefficients, suggesting that not accounting for potential discrepancy in the 0/1 interval biased the model toward the null. The most conservative results are reported (i.e., using score of 0), but results from the successive models are available upon request.

To account for the potential bias introduced due to characteristics associated with loss to follow-up in the subsidized housing sample, the Heckman (42) method was applied, which included the predicted log-odds of participation in the follow-study in the main regression model for subsidized housing families. Inclusion of this variable did not alter the findings (data not shown).

Results

Only 13.6% of families reported no experience of food insecurity in the past 12 mo at both baseline and follow-up interviews and most families were food insecure at both interviews (68.3%), including 22.4% of families who were severely food insecure at both interviews. **Table 1** displays the dynamics of household characteristics for families between interviews, stratified by housing subsidy status. Only 24 market-rent families and 15 subsidized-rent families transitioned to food security by the follow-up interview, though fewer families were newly food insecure at follow-up. Full-time and part-time job losses and gains were experienced by a total of 27% of families. Most families did not experience changes in household composition, partner status, or receipt of welfare between interviews.

Differences between subsidized- and market-rent families were reflected by the higher prevalence of welfare receipt, single motherhood, and lack of full-time employment over both periods among subsidized households. Subsidized-rent families also experienced a higher prevalence of persistent severe food insecurity than market-rent households, though this likely reflects the bias introduced by the greater likelihood of families with severe food insecurity remaining in this sample. Subsidized-rent families remained at significantly lower income levels over both years, as reflected by the high proportion of families below the low income cutoff (39) at both interviews, lower magnitude of change in income, and lower proportion of households that experienced a gain of $2000 in income during the follow-up period.

Although only 18.2% of families in the study population transitioned into or out of food insecurity (Table 1), an examination of the change in number of affirmative responses to questions on the HFSSM between baseline and follow-up (**Supplemental Fig. 2**) showed that 73.4% experienced changes in the severity of their experiences, with 47.7% of families answering 2 more or fewer questions affirmatively at the follow-up interview than they had at baseline.

Among market-rent households, change in income was significantly inversely associated with change in severity of food insecurity (**Table 2**), indicating that the greater the change in income, the greater the change in severity of food insecurity, where a gain of $2000 in household income was associated with a decrease of 0.29 in reported number of affirmed responses on the HFSSM. Changes in the number of adults with full-time and part-time employment were also independently inversely associated with change in severity of food insecurity. Specifically, a gain of an adult with full-time employment was associated with 1.3 fewer affirmative responses being reported at follow-up compared with baseline. Change in receipt of welfare was not associated with change in severity of food insecurity, but few families were newly receiving welfare or no longer receiving welfare at follow-up; thus, the estimate for the change variable was unstable.

Changes in income, employment, and welfare explained little of the variation in change in severity of food insecurity among subsidized-housing families (adjusted $R^2 = 0.06$ for the regression model). Change in income, full-time employment, and welfare were not associated with change in severity of food insecurity, but a change in part-time employment was inversely associated with a change in severity (Table 2).

TABLE 1 Dynamics of household characteristics between baseline and follow-up study visits by housing status (n = 331)[1]

	Market-rent households (n = 145)	Subsidized-rent households (n = 186)	P
Household food security			0.11
Fully food secure at both visits	19 (13.1)	26 (14.0)	
Food insecure at both visits	92 (63.5)	134 (72.0)	
Transitioned to fully food secure	24 (16.6)	15 (8.1)	
Transitioned to food insecure	10 (6.9)	11 (5.9)	
Severe food insecurity			0.0029
Not severe at both visits	108 (74.5)	102 (54.8)	
Severe food insecurity at both visits	21 (14.5)	53 (28.5)	
Transitioned out of severe food insecurity	6 (4.1)	13 (7.0)	
Transitioned into severe food insecurity	10 (6.9)	18 (9.7)	
Baseline number of affirmative responses on HFFSM	4.2 ± 4.0	5.9 ± 4.9	0.0007
Change in number of affirmative responses between baseline and follow-up	−0.2 ± 3.2	−0.3 ± 3.5	0.84
Single mother household			<0.0001
Neither study visit	89 (61.4)	42 (22.6)	
Baseline and follow-up	50 (34.5)	134 (72.0)	
Gained a partner	2 (1.4)	5 (2.7)	
Lost a partner	4 (2.8)	5 (2.7)	
Number of adults			0.81
Same number at both visits	129 (89.0)	162 (87.1)	
Fewer than at baseline	6 (4.1)	11 (5.9)	
More than at baseline	10 (6.9)	13 (7.0)	
Children 18 y of age and younger			0.0187
Same number at both visits	128 (88.3)	176 (94.6)	
Fewer than at baseline	4 (2.8)	6 (3.2)	
More than at baseline	13 (9.0)	4 (2.2)	
Number of full-time jobs in household			<0.0001
None at baseline and follow-up	45 (31.0)	115 (61.8)	
Same number at both visits	67 (46.2)	46 (24.7)	
More than at baseline	25 (17.2)	17 (9.1)	
Fewer than at baseline	8 (5.5)	8 (4.3)	
Number of part-time jobs in household			0.91
None at baseline and follow-up	102 (70.3)	136 (73.1)	
Same number at both visits	16 (11.0)	19 (10.2)	
More than at baseline	13 (9.0)	17 (9.1)	
Fewer than at baseline	14 (9.7)	14 (7.5)	
Received welfare payment in past year			0.0089
None at baseline and follow-up	96 (66.2)	90 (48.4)	
Baseline and follow-up	37 (25.5)	78 (41.9)	
Only baseline visit	7 (4.8)	9 (4.8)	
Only follow-up visit	5 (3.5)	9 (4.8)	
Income below low-income cutoff[2]			<0.0001
Not at baseline or follow-up	32 (22.1)	8 (4.3)	
Baseline and follow-up	72 (49.7)	155 (83.3)	
Only baseline	27 (18.6)	14 (7.5)	
Only follow-up	14 (9.7)	9 (4.8)	
Baseline income,[3] *$*	13,000 ± 3300	10,700 ± 3500	<0.0001
Change in income,[3] *$/y*	2300 ± 4900	800 ± 3200	0.001
Experienced income gain >$2000 over time to follow-up	64 (44.1)	53 (28.35)	0.0031

[1] Values are n (%) for categorical variables or means ± SDs for continuous variables. HFSSM, Household Food Security Survey Module.
[2] Relative to after-tax low income cutoff thresholds published by Statistics Canada for 2006 (39).
[3] Baseline and follow-up income divided by Organization for Economic Co-operation and Development modified scale for household size. Change in income is difference between adjusted values.

Households with only one adult experienced a significantly smaller change in income compared with households with more adults, and households with a respondent who had less than a high school education or only a high school education also had a significantly smaller mean change in income compared with households with a respondent who had a postsecondary education (**Table 3**).

In the logistic regression analysis, baseline characteristics associated with lower odds of gaining full-time work were single adult households, less education, receipt of welfare, and already

TABLE 2 Change in severity of household food security module over time to follow-up in relation to changes in financial vulnerability for market-rent and subsidized-rent households[1]

	Market-rent households		Subsidized-rent households	
	Change in number of affirmative responses		Change in number of affirmative responses	
	$\beta \pm$ SE	*P*	$\beta \pm$ SE	*P*
Change in household income (per $2000)	−0.29 ± 0.10	0.0057	0.03 ± 0.16	0.85
Change in number of adults with full-time employment	−1.33 ± 0.44	0.0028	−0.46 ± 0.65	0.48
Change in number of adults with part-time employment	−1.14 ± 0.56	0.0438	−1.29 ± 0.59	0.0286
Change in receipt of welfare payments	−0.29 ± 0.93	0.76	1.15 ± 0.85	0.18
Minimal score at baseline				
0 affirmative responses	1.82 ± 0.63	0.0046	1.88 ± 0.65	0.0041
≥1 affirmative responses	Reference		Reference	
Maximal score at baseline				
17 affirmative responses	−3.81 ± 2.18	0.08	−1.52 ± 3.53	0.67
≤16 affirmative responses	Reference		Reference	

[1] Data are from linear regression models adjusted for all other variables in table.

having full-time employment in household at baseline (**Table 4**). Households with ≥3 adults or with only a high school education were significantly more likely to have gained part-time work (Table 4).

Discussion

This study uses the full range of the HFSSM scale to examine the dynamic relationship between changes in severity of food insecurity and income and employment, uniquely providing an examination of the dynamics of food insecurity in a low-income Canadian study population during 1 y. We observed a significant association between income change and change in severity of food insecurity among market-rent families, suggesting that greater income gains led to greater improvements in severity of food insecurity and that, conversely, greater income losses led to greater deterioration. Although a dynamic relationship between income changes and a change in food sufficiency status has been observed among welfare families in Michigan (30), this study builds on this finding by documenting that during a short follow-up period, changes in income and employment related to changes in severity of household experiences of food insecurity as measured by the HFSSM. The aggregate number of affirmative responses on the HFSSM module has been used as an outcome variable in other studies (18,20,26), one of which utilized longitudinal data (18), but to the best of our knowledge, none have focused on within-household change in relation to within-household changes income and household employment status during a short time frame. One exception was a study based in Burkina Faso (43), which used a similar scale instrument to measure household food insecurity and related change in food insecurity score to other household changes during time intervals of 6 mo. This study also provided validation that a change in household food insecurity scale score is reflective of economic changes within households. Observations of a dynamic relationship between these variables within households suggests that introductions of policies that raise household incomes and employment would improve the situations of food-insecure households and that protections against income losses may prevent deterioration for households experiencing food insecurity.

As discussed by Leete and Bania (28), the responsiveness of food insecurity to negative income shocks must be affected by a household's access to resources that protect households from feeling the impact of these changes, such as liquid assets and access to credit. Similarly, benefits of income gains may be offset by debt. We did not specifically measure debt, savings, or access to credit so could not evaluate interactions with income changes in our sample; therefore, our estimates could be biased toward null. However, because most families in the sample were already food insecure, this could indicate that protective financial resources were already exhausted, because households that are food insufficient or food insecure have been observed to lack these resources (26,27,29). In spite of a lack of information on other financial resources, the findings

TABLE 3 Change in income over time to follow-up in relation to baseline household characteristics (n = 331)[1]

	Households	Change in income ($/y)	
		$\beta \pm$ SE	*P*
	n		
Adults living in household, *n*			
1	169	−1100 ± 500	0.0398
2	133	Reference	
≥3	29	−100 ± 800	0.94
Children living in household, *n*			
1	123	900 ± 500	0.09
2	106	400 ± 600	0.44
≥3	102	Reference	
Respondent education			
Less than high school	73	−1900 ± 600	0.0045
Completed high school	117	−1100 ± 500	0.0387
Postsecondary	141	Reference	
Years since immigration			
<10	93	800 ± 700	0.28
≥10	167	600 ± 500	0.31
Born in Canada	71	Reference	
Highest work status			
None	143	−800 ± 600	0.20
Part-time	48	−100 ± 700	0.90
Full-time	140	Reference	
Received welfare			
No	200	−300 ± 600	0.60
Yes	131	Reference	
Received disability support			
No	304	−400 ± 900	0.65
Yes	27	Reference	

[1] Data are from linear regression model adjusted for all variables in table.

TABLE 4 Gain of full-time and part-time employment over time to follow-up in relation to baseline household characteristics (n = 331)[1]

	Gained full-time work	Adjusted OR (95% CI)	Gained part-time work	Adjusted OR (95% CI)
	%		%	
Adults living in household, *n*				
1	9.5	0.44 (0.19–0.998)	7.7	0.64 (0.23–1.80)
2	15.8	Reference	8.3	Reference
≥3	17.2	1.12 (0.34–3.67)	20.7	4.02 (1.20–13.45)
Children living in household, *n*				
1	11.4	0.67 (0.29–1.58)	7.3	0.93 (0.33–2.59)
2	10.4	0.73 (0.30–1.77)	11.3	1.44 (0.54–3.85)
≥3	16.7	Reference	8.8	Reference
Respondent education				
Less than high school	9.6	0.42 (0.15–1.17)	9.6	2.43 (0.67–8.80)
Completed high school or GED	8.6	0.38 (0.16–0.91)	14.5	4.61 (1.56–13.59)
Postsecondary	17.7	Reference	4.3	Reference
Years since immigration				
<10	12.9	Reference	7.5	Reference
≥10	12.0	1.25 (0.52–2.96)	10.8	1.08 (0.40–2.94)
Born in Canada	14.1	2.39 (0.80–7.20)	7.0	0.71 (0.19–2.64)
Highest work status				
None	14.7	7.32 (2.76–19.38)	11.2	1.36 (0.45–4.12)
Part-time	20.8	6.71 (2.35–19.20)	2.1	0.13 (0.01–1.24)
Full-time	7.9	Reference	9.3	Reference
Received welfare				
No	15.5	Reference	9.0	Reference
Yes	8.4	0.27 (0.11–0.66)	9.2	1.05 (0.37–2.96)
Received disability support				
No	13.2	Reference	8.2	Reference
Yes	7.4	0.27 (0.05–1.33)	18.5	2.13 (0.62–7.35)

[1] Data are from logistic regression models adjusted for all variables in table.

suggest that income flow was central in determining the severity of experiences among vulnerable households.

The lack of association among subsidized-rent households may relate to the above discussion in that income gains in this group would have been partially offset by concomitant increases in rent. An alternate explanation is that although some families experienced income changes, families in this group were less sensitive to change given the greater depth of poverty and severity of food insecurity.

We observed that changes in number of household members with employment, particularly full-time employment among market-rent households, were associated with changes in severity of food insecurity independent of income change. The independence of these relationships could reflect improvements in financial resources available for food not captured in income, such as improved access to credit and prescription drug and dental insurance, which would free up money for food if these were a source of household expense. Studies of low-income Canadians have shown that compared with unemployed low-income Canadians, employed low-income households report greater ability to use lines of credit or credit cards to cover unexpected expenses (44) and almost one-half of low-income employed households have access to employment-related dental insurance coverage (45). Information on access to credit and employment-related benefits was not collected in this study, however, so we could not examine whether a change in access to these resources was underlying the association observed between change in employment status and severity of food insecurity. There is a need to examine how these types of material resources relate to household food insecurity in Canada, as these could be important levers for policy intervention for working and nonworking households alike. The relationship between a gain in employment and reduction in severity of food insecurity observed in this study provides support for improving availability of secure employment opportunities and incentives and support for transition from welfare to work as highlighted as key priorities in a recently commissioned review of social assistance in Ontario (46). This said, we are cautious to make conclusions about the sufficiency of employment as an antidote for food insecurity, because employment is not coincident with food security in Canada, where >50% of food-insecure households receive their main source of income from employment [author calculation from (47)]. A recent study of food insecurity among households with employment highlighted that working households with only one waged worker, single mothers, larger household sizes, and low incomes were more likely to be food insecure (48).

Further, the patterning of income changes and full-time job changes in the sample suggests that particularly vulnerable households are disadvantaged in potential to experience improvement in food insecurity if improvement is contingent on employment. Households with only one adult (namely, all single mothers with no adult children) and lower education experienced significantly lower income gains and fewer of them gained full-time work. These characteristics could reflect both barriers to gaining work and poorer quality of current employment. Because gaining any or additional employment, increasing work hours, receiving wage increases, or gaining better paid work may not be possible for many households facing food insecurity, particularly single

parents with low education levels, there is a need for policy that positively influences availability and security of material resources independent of employment in Canada. Concern about the adequacy of current welfare rates for unemployed Canadians has repeatedly been highlighted (49–51) and social assistance recipients remain the most vulnerable group to food insecurity in Canada (47). Improvement to the current tax transfer system for low-income working Canadians has also been recommended (52).

The study population provided a unique opportunity for an analysis of dynamics between financial resources and severity of food insecurity because of the relatively high proportion of families who had affirmative responses on the HFSSM. In addition to implications for intervention, the results provide a methodological contribution to the literature on the measurement of household food security through use of the HFSSM by showing that movement up and down the scale within households was related to changes in household financial circumstances, thus suggesting that the scale can track changes in severity. There has been little assessment of the stability of intra-individual reporting on household food insecurity over time and some movement up and down the scale observed in this study must be due to variation in this regard, but the observation that movement was related to changes in household financial circumstances suggests that movement reflects meaningful changes within households. An inherent assumption of the fixed-effect model is that the change in raw scale score is equivalent relative to change in the predictor variables, regardless of where the movement occurred on the scale and what changes in experiences the change in raw score represented. Further research is needed to explore the meaning of changes at different points on the scale.

As discussed, this study was limited by a lack of information about other factors that could have explained the unaccounted-for variation in severity of food insecurity between baseline and follow-up, particularly for subsidized-housing families, and also by a lack of detail on the timing of changes within the household. The associations observed could have been attenuated by the temporal mismatch between predictor variables of interest and the outcome variable. By design, the HFSSM captures the most severe circumstance that occurred at any time in the past year, so conceivably the severity of food insecurity could reflect a time before gains in income or employment occurred, which would lead to an attenuation of parameter estimates.

It is possible that the stability of household characteristics observed for most study participants over the study period was over-represented if more significant changes, either positive or negative, influenced the ability to recontact households (i.e., relocation due to gain of employment or loss of housing). In many cases, the loss to follow-up was due to an inability to recontact participants, because they had moved or phone numbers were disconnected, rather than refusal to participate in the follow-up study (Supplemental Fig. 1). The generalizability of our findings is potentially limited, as the sample was limited to low-income, tenant families with children living in Toronto; however, the characteristics of vulnerability to food insecurity in the sample (31,32) were consistent with findings from nationally representative data (35) and the findings are consistent with other studies that have suggested a dynamic relationship between income and food insufficiency (27,28,30).

In conclusion, this study shows that income and employment changes within households are associated with changes in severity of food insecurity, highlighting the sensitivity of food-insecure households to changes in their financial circumstances. These findings suggest that improvements in income and employment of food-insecure households would improve their situations, whereas a lack of protection from negative changes may lead to worsening circumstances for households that experience declines in income and employment. These results provide evidence to support development of public policy aimed at improving the material resources of food-insecure households to ameliorate the severity of their experiences. Given the magnitude of the problem of food insecurity, there is an urgent need for development and evaluation of policy targeted toward food-insecure households in Canada, where currently there is no public policy targeted toward amelioration or prevention of this problem.

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