

Child Hunger and Long-term Adverse Consequences for Health

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Objective: To examine the effects of hunger, an extreme manifestation of food insecurity, on subsequent health outcomes using data from the Canadian National Longitudinal Survey of Children and Youth (NLSCY).

Design: Longitudinal survey, 1994-2004/2005.

Setting: Canada.

Participants: A total of 5809 children aged 10 to 15 years and 3333 youth aged 16 to 21 years.

Main Exposures: Longitudinal survey data spanning a 10-year period were analyzed using logistic regression. Measures of hunger from NLSCY cycles 1 through 5 were used to differentiate participants who were ever hungry from those who were never hungry. A 3-level variable was created to assess the effect of repeated episodes of hunger. Covariates included participants' age, sex, baseline health, and household sociodemographic characteristics. Stratified models were used to examine the relation between hunger and health among boys and girls separately.

Outcome Measures: The NLSCY cycle 6 outcomes included poor general health, chronic health conditions, and asthma.

Results: Among children, both ever being hungry and multiple episodes of hunger were associated with poorer general health but not with chronic conditions or asthma. Higher odds of chronic conditions and of asthma were observed among youth who experienced multiple episodes of hunger compared with those who were never hungry. Associations between hunger and poorer health outcomes persisted among girls in stratified analyses.

Conclusions: Children and youth who experience hunger are more likely to have poorer health, and repeated exposure appears to be particularly toxic. Our findings point to the relevance of food insecurity in childhood as a marker of vulnerability, with implications for clinical practice and advocacy.

Arch Pediatr Adolesc Med. 2010;164(8):754-762

FOOD INSECURITY, WHICH REFERS to financial challenges in accessing adequate food, was estimated to affect approximately 1 in 10 households in Canada in 2004.¹ One in 20 households with children reported food insecurity at the child level in that year, indicating compromises in the quantity and/or quality of food consumed by children.¹ More recent data collected by charitable food programs suggest that food insecurity may be on the rise in Canada.² Similarly, the most recent statistics from the United States indicate that 15% of American households experienced food insecurity in 2008, up from 11% in 2007 and marking the highest prevalence recorded since national monitoring of food insecurity began in 1995.³

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Evidence of an increase in the number of food-insecure households in North America is alarming given a growing body of literature suggesting that food insecurity is associated with a range of poor out-

comes among children.⁴⁻¹³ We previously found higher rates of poor health and asthma among children who experienced hunger (the most extreme manifestation of food insecurity, now referred to as severe food insecurity¹ or very low food security³) in our analysis of cross-sectional data from the first cycle of the Canadian National Longitudinal Survey of Children and Youth (NLSCY).¹¹ Similarly, a US cross-sectional study found higher odds of fair or poor health and of hospitalization among children in food-insecure households, with those in households reporting food insecurity at the level of children affected to a greater degree.¹² A recent longitudinal study conducted in the United States also suggests that food insecurity is related to poor health outcomes among children.¹³ However, the bulk of the research in this area has been cross-sectional; thus, the long-term effect of food insecurity in childhood on health remains poorly understood. It is also unclear whether the childhood experience of hunger leads to its own adverse health outcomes independent of the effects of poverty in general as a risk factor for poor health.

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Table 1. Odds of Ever Experiencing Hunger in Cycles 1 Through 5 in Relation to Participant and Household Characteristics^a

Variable	Children Aged 10-15 y (n=5809)		Youth Aged 16-21 y (n=3333)	
	Mean (SE)	OR (95% CI) of Ever Experiencing Hunger	Mean (SE)	OR (95% CI) of Ever Experiencing Hunger ^b
Age, y	12.5 (0.006)	1.19 (1.02-1.39)	18.5 (0.02)	1.09 (0.91-1.31)
Average household income, CAD\$ ^c	64 409 (1098)	0.98 (0.96-0.99)	63 867 (1353)	0.96 (0.94-0.98)
Adults, No.	2.03 (0.01)	0.53 (0.27-1.03)	2.10 (0.02)	0.56 (0.28-1.11)
Children, No.	2.29 (0.02)	1.40 (1.05-1.88)	2.14 (0.03)	1.53 (1.00-2.35)
Sex	No. (%)		No. (%)	
Female	2847 (49.0)	0.99 (0.56-1.73)	1663 (49.9)	1.30 (0.72-2.34)
Male	2962 (51.0)	1.00 [Reference]	1670 (50.1)	1.00 [Reference]
Housing tenure				
Rented in at least 1 cycle	2470 (42.5)	5.91 (2.60-13.43)	928 (27.8)	2.27 (1.01-5.08)
Owned	3339 (57.5)	1.00 [Reference]	2405 (72.2)	1.00 [Reference]
Area of residence				
Rural in at least 1 cycle	1415 (24.4)	1.17 (0.69-1.96)	749 (22.5)	0.94 (0.51-1.74)
Urban	4394 (75.6)	1.00 [Reference]	2584 (77.5)	1.00 [Reference]
Identity of PMK				
Biological mother	4192 (72.2)	0.50 (0.27-0.92)	2589 (77.7)	0.95 (0.44-2.05)
Individual other than biological mother in at least 1 cycle	1617 (27.8)	1.00 [Reference]	744 (22.3)	1.00 [Reference]

Abbreviations: CI, confidence interval; OR odds ratio; PMK, person most knowledgeable about participant.

^aORs are adjusted for all other variables in the table.

^bHunger characterization for youth based on PMK reports only.

^cORs for household income pertain to increments of CAD \$1000.

In this study, we extend our prior analysis by analyzing NLSCY data spanning a 10-year period to examine whether the experience of hunger during childhood is associated with poorer subsequent health outcomes, conditional on baseline health and independent of other influences on health including markers of household socioeconomic status.

METHODS

DATA

The NLSCY is a long-term survey focused on the development and well-being of Canadian children from birth to early adulthood, with data collection occurring on a biennial basis since 1994.¹⁴ For this study, we analyzed data covering 1994 through 2004/2005, with data on hunger drawn from NLSCY cycles 1 (C1; 1994) through 5 (C5; 2002/2003) and health outcome data drawn from cycle 6 (C6; 2004/2005). Two cohorts were studied: children aged 10 to 15 years in C6 (0-5 years in C1) and youth aged 16 to 21 years in C6 (6-11 years in C1). The C1 cohort members for whom data were available for each subsequent cycle up to C6 consisted of 9661 respondents. After excluding children and youth with incomplete data for the key analytic variables (n=519; 5% of respondents), our analytic sample included 9142 respondents (5809 children and 3333 youth). Excluded children were more likely to be older, male, and living in lower-income households and less likely to have ever lived in a rural area or in rental housing.

MEASURES

Hunger

Experiences of hunger were assessed in each cycle through a question administered to the person most knowledgeable (PMK) about the child that asked, "Has [the child] ever exper-

rienced being hungry because the family has run out of food or money to buy food?" The response options were yes or no. This question was administered directly to persons aged 16 to 17 years in C4 and C5. The C5 questionnaire also included a modified hunger indicator (relating to the past 6 months rather than ever) that was administered to persons aged 18 and 19 years. Our previous analysis showed changes in hunger status across cycles in relation to changes in known risk factors for food insecurity (eg, income and household composition),¹⁵ suggesting that the reference period (usually, ever) is interpreted as the time that elapsed since the previous administration of the survey. A child or youth was considered to have ever experienced hunger if an affirmative response was given in at least 1 cycle from C1 to C5. To enable an assessment of the relationship between health outcomes and the persistence of the hunger experience, a 3-level variable was also created to differentiate those who were never hungry from those who were hungry in 1 cycle and those with 2 or more episodes of hunger. To account for the possible bias associated with differences in reporting, 2 sets of hunger variables were created for use in the analysis of data for youth, 1 based on PMK-reported hunger only and a second based on both PMK reports and youth self-reports.

Health Outcomes

The C6 (ie, 10-year) health outcomes were reported by the PMK on behalf of children and self-reported by youth. A child/youth was considered to have poor health status if health was reported to be poor, fair, or good vs very good or excellent; this split was used because most reports of health were very good or excellent. A child or youth was considered to have a chronic health condition if he/she had been diagnosed with a heart condition, cerebral palsy, epilepsy, kidney disease, asthma, bronchitis, or allergies. Asthma was also considered separately because of its relatively high prevalence and because of our earlier finding of its association with child hunger.¹¹

Table 2. Odds of Poor Health Status, Diagnosed Chronic Health Conditions, and Asthma Among Children (n=5809) in Cycle 6 in Relation to Ever Experiencing Hunger in Cycles 1 Through 5^a

Variable	Odds Ratio (95% Confidence Interval)		
	Poor General Health	Diagnosed Chronic Condition	Asthma
Hunger			
Ever hungry	2.48 (1.32-4.64)	1.11 (0.59-2.09)	1.41 (0.79-2.51)
Never hungry	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Age, y	1.08 (1.00-1.17)	0.98 (0.93-1.03)	0.94 (0.88-1.01)
Sex			
Female	1.15 (0.87-1.50)	0.77 (0.64-0.92)	0.66 (0.52-0.84)
Male	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Average household income ^b	0.99 (0.98-0.99)	1.00 (1.00-1.00)	1.00 (1.00-1.00)
Adults, No.	1.16 (0.85-1.59)	0.94 (0.74-1.20)	0.87 (0.63-1.19)
Children, No.	0.97 (0.83-1.14)	0.72 (0.64-0.82)	0.76 (0.66-0.88)
Housing tenure			
Rented in at least 1 cycle	1.25 (0.91-1.72)	1.00 (0.79-1.26)	1.02 (0.77-1.34)
Owned	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Area of residence			
Rural in at least 1 cycle	1.04 (0.80-1.35)	0.91 (0.75-1.10)	0.98 (0.77-1.24)
Urban	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Identity of PMK			
Biological mother	0.91 (0.65-1.26)	1.11 (0.91-1.36)	1.02 (0.78-1.32)
Individual other than biological mother in at least 1 cycle	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Poor health, chronic condition, or asthma at baseline			
Yes ^c	1.91 (1.33-2.74)	3.69 (2.91-4.68)	12.97 (8.94-18.81)
No	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Child has chronic condition in C6			
Yes	1.64 (1.23-2.18)		
No	1.00 [Reference]		
Child takes prescription medication in C6			
Yes	3.00 (2.21-4.07)		
No	1.00 [Reference]		

Abbreviations: C6, cycle 6; PMK, person most knowledgeable about participant.

^aOdds ratios are adjusted for all other variables in the table.

^bOdds ratios for household income pertain to increments of CAD \$1000.

^cBaseline general health status was not stated for 133 children; baseline chronic condition status was not stated for 135 children; and baseline asthma status was also not stated for 135 children. A dummy variable was included in the model to indicate not stated baseline health status for each outcome; the odds of poorer health outcomes in C6 among those whose baseline health status was not stated did not differ from the odds among those who did not have poor health at baseline.

STATISTICAL ANALYSIS

Analyses were conducted using SAS, version 9.2 (SAS Inc, Cary, North Carolina) and were weighted using longitudinal funnel weights. Standard error estimates were generated using bootstrap weights to account for the complex survey design of NLSCY.¹⁴

Logistic regression was used to assess the association between hunger and each of the 3 health outcomes (health status, chronic conditions, and asthma), separately for children and youth. Because we were interested in whether hunger was associated with poorer health independent of other potential influences, models included age, sex, and baseline health as well as household sociodemographic variables associated with poverty. Baseline status for each health outcome was obtained from analogous data collected via the C1 PMK questionnaire. Parsimonious models were desirable because the rarity of child hunger (see “Results” section for prevalence among children and youth) limited our statistical power; thus, we included a limited number of sociodemographic variables. The selection of these variables was informed by preliminary analysis including stepwise regression models as well as previous literature.^{11,15} Sociodemographic information for children was retrieved from C1 through C5; for youth, such information was consistently available for C1 through C4. To account for potential changes in household sociodemographic characteristics over time, we derived variables to indicate average household income (expressed in increments of CAD \$1000), the average number of adults and children in the house-

hold, whether the household ever lived in a rented dwelling, and whether the household ever lived in a rural area. The latter 2 variables were included as additional indicators of household socioeconomic situation; both have been associated with food security status among Canadian households.¹

The general health status models also included a variable indicating whether the child had a chronic health condition so that we could account for the possibility that any observed associations between hunger and poor health were mediated by chronic illness. The general health status models were repeated including a more broadly defined chronic condition variable that encompassed the health conditions noted above plus additional conditions that might influence perceptions of general health status including mental handicaps, learning disabilities, emotional, psychological, or nervous difficulties, attention-deficit disorder, or any other long-term condition diagnosed by a physician. However, the consideration of this broader range of conditions did not change the associations we observed; thus, we present only the results based on our original chronic health condition variable. A variable indicating whether children took prescription medicine (applicable to 14.0% of children) was also included in the general health status model; this information was not available for youth.

To account for possible reporting biases, a dummy variable indicating whether the PMK was ever someone other than the biological mother (applicable to 28.4% of children and 22.3% of youth) was included in all models. Further, we repeated our analysis of

Table 3. Odds of Poor Health Status, Diagnosed Chronic Health Conditions, and Asthma Among Youth (n=3333) in Cycle 6 in Relation to Ever Experiencing Hunger in Cycles 1 Through 5^a

Variable	Odds Ratio (95% Confidence Interval)		
	Poor General Health	Diagnosed Chronic Condition	Asthma
Hunger			
Ever hungry	1.60 (0.89-2.87)	1.33 (0.67-2.67)	2.66 (0.93-7.63)
Never hungry	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Age, y	1.07 (0.99-1.16)	0.96 (0.88-1.04)	0.95 (0.85-1.07)
Sex			
Female	1.71 (1.35-2.18)	1.31 (1.01-1.69)	1.58 (1.01-2.46)
Male	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Average household income ^b	1.00 (0.99-1.00)	1.00 (1.00-1.01)	1.00 (1.00-1.01)
Adults, No.	0.90 (0.70-1.16)	1.02 (0.75-1.38)	1.34 (0.81-2.22)
Children, No.	0.92 (0.79-1.08)	0.93 (0.80-1.08)	0.99 (0.77-1.27)
Housing tenure			
Rented in at least 1 cycle	1.45 (1.07-1.96)	1.23 (0.87-1.74)	1.04 (0.55-1.94)
Owned	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Area of residence			
Rural in at least 1 cycle	1.15 (0.91-1.46)	0.84 (0.66-1.06)	0.69 (0.47-1.00)
Urban	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Identity of PMK			
Biological mother	0.98 (0.74-1.31)	0.83 (0.60-1.16)	0.67 (0.37-1.21)
Individual other than biological mother in at least 1 cycle	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Poor health, chronic condition, or asthma at baseline			
Yes ^c	1.59 (1.14-2.22)	4.65 (3.60-6.01)	11.8 (7.43-18.76)
No	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Chronic condition in C6			
Yes	1.29 (0.98-1.69)		
No	1.00 [Reference]		

Abbreviations: C6, cycle 6; PMK, person most knowledgeable about participant.

^aOdds ratios are adjusted for all other variables in the table.

^bOdds ratios for household income pertain to increments of CAD \$1000.

^cBaseline general health status was not stated for 46 youth; baseline chronic condition status was not stated for 48 youth; and baseline asthma status was not stated for 47 youth. A dummy variable was included in the model to indicate not stated baseline health status for each outcome; the odds of poorer health outcomes in C6 among those whose baseline health status was not stated did not differ from the odds among those who did not have poor health at baseline.

youth using variables based on both PMK and youth reports of hunger, and note differences observed compared with analyses based on only PMK reports of hunger in the results section.

In addition to models for children and youth, stratified analyses were conducted to assess the association between hunger and each health outcome among boys and girls separately. For the stratified models, data from the cohorts of children and youth were combined to maximize statistical power, only PMK hunger reports were considered (because they were available and measured consistently for both cohorts in contrast to youth self-reports), and a dummy variable indicating the cohort was included as a means of accounting for other reporting differences, eg, in health outcomes.

RESULTS

The characteristics of children and youth in the sample are presented in **Table 1**.

PREVALENCE AND PREDICTORS OF HUNGER

The hunger experience was relatively uncommon. Among children aged 10 to 15 years, 3.3% had ever experienced hunger and 1.1% were hungry in 2 or more cycles. Among youth aged 16 to 21 years, 3.9% were classified as having ever experienced hunger and 1.4% were hungry in 2 or more cycles. When combined PMK/youth self-reports were con-

sidered, the prevalence of ever experiencing hunger among youth rose to 7.6%, and 1.8% were hungry in 2 or more cycles.

For children, higher odds of experiencing hunger were observed with increasing age, increasing number of children in the household, and ever having lived in a rented dwelling, whereas lower odds were observed with increasing income and among children for whom the PMK was the biological mother in all cycles (Table 1). Among youth, higher odds of hunger were observed among those who had ever lived in a rented dwelling and lower odds were observed with increasing income (Table 1). Predictors of hunger among youth based on both PMK and youth reports were similar, although hunger was also positively associated with child age and negatively associated with the number of adults in the household (data not shown).

HEALTH OUTCOMES

Overall, more than 1 in 10 (13.5%) children were classified as being in poor health; 32.9% of those who had ever experienced hunger were reported to be in poor health compared with 12.8% of those who had never experienced hunger. Almost one-third of all children (32.7%; 36.9% of ever-hungry children compared with 32.6% of never-hungry children) were reported to have a diagnosed chronic condition, and 18.3% were reported to have

Table 4. Odds of Poor Health Status, Diagnosed Chronic Health Conditions, and Asthma Among Children (n=5809) in Cycle 6 in Relation to Persistence of Hunger in Cycles 1 Through 5^a

Variable	Odds Ratio (95% Confidence Interval)		
	Poor General Health	Diagnosed Chronic Condition	Asthma
Hunger			
1 episode	1.68 (0.68-4.16)	0.92 (0.43-1.96)	1.46 (0.69-3.11)
2 or more episodes	4.73 (2.05-10.93)	1.58 (0.62-4.01)	1.32 (0.54-3.23)
Never hungry	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Age, y	1.08 (1.00-1.17)	0.98 (0.93-1.03)	0.94 (0.88-1.01)
Sex			
Female	1.14 (0.87-1.50)	0.77 (0.64-0.92)	0.66 (0.52-0.84)
Male	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Average household income ^b	0.99 (0.98-0.99)	1.00 (1.00-1.00)	1.00 (1.00-1.00)
Adults, No.	1.15 (0.84-1.58)	0.94 (0.73-1.20)	0.87 (0.63-1.19)
Children, No.	0.98 (0.84-1.15)	0.72 (0.64-0.82)	0.76 (0.66-0.88)
Housing tenure			
Rented in at least 1 cycle	1.26 (0.92-1.73)	1.00 (0.79-1.27)	1.02 (0.77-1.34)
Owned	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Area of residence			
Rural in at least 1 cycle	1.05 (0.81-1.37)	0.91 (0.76-1.10)	0.98 (0.77-1.24)
Urban	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Identity of PMK			
Biological mother	0.90 (0.64-1.25)	1.11 (0.91-1.36)	1.02 (0.78-1.32)
Individual other than biological mother in at least 1 cycle	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Poor health, chronic condition, or asthma at baseline			
Yes ^c	1.92 (1.34-2.76)	3.69 (2.90-4.69)	12.96 (8.94-18.81)
No	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Child has chronic condition in C6			
Yes	1.63 (1.22-2.17)		
No	1.00 [Reference]		
Child takes prescription medication in C6			
Yes	3.00 (2.21-4.06)		
No	1.00 [Reference]		

Abbreviations: C6, cycle 6; PMK, person most knowledgeable about participant.

^aOdds ratios are adjusted for all other variables in the table.

^bOdds ratios for household income pertain to increments of CAD \$1000.

^cBaseline general health status was not stated for 133 children; baseline chronic condition status was not stated for 135 children; and baseline asthma status was also not stated for 135 children. A dummy variable was included in the model to indicate not stated baseline health status for each outcome; the odds of poorer health outcomes in C6 among those whose baseline health status was not stated did not differ from the odds among those who did not have poor health at baseline.

asthma in C6 (24.8% of ever-hungry children compared with 18.0% of never-hungry children).

Poor health in C6 was reported by more than a quarter (28.6%) of youth (47.3% of ever-hungry youth reported their health as poor compared with 27.9% of never-hungry youth); a diagnosed chronic condition was reported by 30.5% (41.7% of ever-hungry compared with 30.1% of never-hungry youth); and 11.7% of youth (27.1% of ever-hungry compared with 11.1% of never-hungry youth) reported having asthma.

GENERAL HEALTH STATUS

After accounting for baseline health and other potential confounders, higher odds of poor health status were observed among children who had experienced hunger compared with those who were never hungry (**Table 2**). Positive associations were also observed between poor health status and poor baseline health, presence of a chronic condition, and use of prescription medication, while poor health status was negatively associated with income (Table 2).

Among youth, ever having experienced hunger was not associated with general health status in C6 (**Table 3**);

this did not change when the PMK/youth combined ever-hungry variable was used (odds ratio, 1.46; 95% confidence interval, 0.95-2.24). Poor health among youth was positively associated with poor baseline health, female sex, and living in rental housing (Table 3).

For children but not youth, the analysis comparing those who were never hungry with those who were hungry in 1 cycle and those who were persistently hungry revealed higher odds of poor health among those who were hungry in 2 or more cycles compared with those who never experienced hunger (**Table 4** and **Table 5**).

In the combined cohort of children and youth, hunger was associated with higher odds of poor health; this effect persisted for girls but not boys in the stratified models (**Table 6**).

CHRONIC CONDITIONS

No associations were observed between whether children had a diagnosed chronic health condition and hunger using either the dichotomous (ever/never hungry; Table 2) or 3-level (once, more than once, or never hungry; Table 4) hunger variables. Among children, having

Table 5. Odds of Poor Health Status, Diagnosed Chronic Health Conditions, and Asthma Among Youth (n=3333) in Cycle 6 in Relation to Persistence of Hunger in Cycles 1 Through 5^a

Variable	Odds Ratio (95% Confidence Interval)		
	Poor General Health	Diagnosed Chronic Condition	Asthma
Hunger			
1 episode	1.17 (0.55-2.49)	0.79 (0.34-1.86)	1.50 (0.35-6.41)
2 or more episodes	2.93 (0.93-9.28)	3.40 (1.10-10.48)	6.08 (1.43-25.85)
Never hungry	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Age, y	1.07 (1.00-1.16)	0.96 (0.88-1.04)	0.95 (0.85-1.07)
Sex			
Female	1.72 (1.35-2.19)	1.31 (1.01-1.69)	1.57 (1.01-2.46)
Male	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Average household income ^b	1.00 (0.99-1.00)	1.00 (1.00-1.01)	1.00 (1.00-1.01)
Adults, No.	0.90 (0.70-1.16)	1.02 (0.75-1.38)	1.34 (0.81-2.23)
Children, No.	0.92 (0.78-1.07)	0.92 (0.79-1.06)	0.97 (0.76-1.25)
Housing tenure			
Rented in at least 1 cycle	1.46 (1.08-1.97)	1.23 (0.87-1.75)	1.04 (0.56-1.95)
Owned	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Area of residence			
Rural in at least 1 cycle	1.16 (0.91-1.47)	0.84 (0.67-1.07)	0.70 (0.48-1.03)
Urban	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Identity of PMK			
Biological mother	0.99 (0.74-1.33)	0.84 (0.60-1.18)	0.68 (0.38-1.23)
Individual other than biological mother in at least 1 cycle	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Poor health, chronic condition, or asthma at baseline			
Yes ^c	1.58 (1.13-2.20)	4.65 (3.60-6.01)	11.87 (7.45-18.89)
No	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Youth has chronic condition in C6			
Yes	1.27 (0.96-1.67)		
No	1.00 [Reference]		

Abbreviations: C6, cycle 6; PMK, person most knowledgeable about participant.

^aOdds ratios are adjusted for all other variables in the table.

^bOdds ratios for household income pertain to increments of CAD \$1000.

^cBaseline general health status was not stated for 46 youth; baseline chronic condition status was not stated for 48 youth; and baseline asthma status was not stated for 47 youth. A dummy variable was included in the model to indicate not stated baseline health status for each outcome; the odds of poorer health outcomes in C6 among those whose baseline health status was not stated did not differ from the odds among those who did not have poor health at baseline.

a chronic health condition was positively associated with baseline presence of a chronic condition and negatively associated with the number of children in the household and female sex (Table 2).

Ever having experienced hunger as reported by the PMK was not associated with having a chronic health condition among youth (Table 3); this was also the case when both PMK and youth hunger reports were considered (odds ratio, 0.91; 95% confidence interval, 0.53-1.58). The 3-level PMK-reported hunger model revealed higher odds of having a chronic condition among youth with 2 or more episodes of hunger, compared with those who never experienced hunger (Table 5). Among youth, having a diagnosed chronic health condition was positively associated with having a chronic condition at baseline and female sex (Table 3).

Ever having experienced hunger was not associated with chronic health conditions among the combined child/youth sample, nor among the stratified samples of boys or girls (Table 6).

ASTHMA

Asthma was not associated with ever having experienced hunger among children but was positively associated with baseline presence of asthma and negatively associated with the number of children in the household and female sex (Table 2).

Among youth, asthma in C6 was not associated with ever being hungry but was positively associated with baseline asthma and female sex (Table 3). When both PMK and youth hunger reports were considered, a significant association between ever experiencing hunger and asthma was observed among youth (odds ratio, 2.38; 95% confidence interval, 1.14-4.94).

For youth but not children, the 3-level hunger models revealed higher odds of asthma among those with 2 or more PMK-reported hunger episodes (Table 4 and Table 5).

Among the combined child/youth cohort, a positive association was observed between ever experiencing hunger and asthma among girls but not boys (Table 6).

In summary, both ever being hungry and multiple episodes of hunger were associated with poorer health status among children. Youth with repeated episodes of hunger exhibited higher odds of chronic conditions and asthma. For health status and asthma, negative effects of hunger persisted for girls but not boys in stratified models using the combined sample of children and youth.

COMMENT

This study indicates that children who experience hunger are more likely to suffer from poorer health outcomes, even when baseline health and household mark-

Table 6. Odds of Poor Health Status, Diagnosed Chronic Condition, and Asthma in Cycle 6 in Relation to Ever Experiencing Hunger in Cycles 1 Through 5 in Combined Sample by Sex^a

Variable	Odds Ratio (95% Confidence Interval)					
	Poor General Health			Diagnosed Chronic Condition		
	All Participants (n=9142)	Boys (n=4632)	Girls (n=4510)	All Participants (n=9142)	Boys (n=4632)	Girls (n=4510)
Hunger						
Ever hungry	1.91 (1.26-2.89)	1.44 (0.73-2.86)	2.40 (1.31-4.39)	1.22 (0.75-1.99)	0.81 (0.43-1.51)	1.77 (0.93-3.35)
Never hungry	1.08 (1.03-1.14)	1.11 (1.02-1.21)	1.06 (0.99-1.14)	0.96 (0.92-1.00)	0.93 (0.87-0.98)	1.00 (0.94-1.06)
Age,y						
Sex						
Female	1.43 (1.18-1.72)			0.97 (0.83-1.13)		
Male	1.00 [Reference]			1.00 [Reference]		
Average household income ^b	1.00 (0.99-1.00)	0.99 (0.99-1.00)	1.00 (0.99-1.00)	1.00 (1.00-1.00)	1.00 (1.00-1.00)	1.00 (1.00-1.00)
Adults, No.	0.96 (0.79-1.18)	1.06 (0.79-1.42)	0.91 (0.70-1.19)	0.96 (0.80-1.17)	1.09 (0.84-1.41)	0.88 (0.65-1.18)
Children, No.	0.95 (0.85-1.05)	0.94 (0.80-1.10)	0.95 (0.82-1.11)	0.81 (0.74-0.89)	0.83 (0.72-0.95)	0.78 (0.69-0.89)
Housing tenure						
Rented in at least 1 cycle	1.39 (1.11-1.74)	1.32 (0.96-1.80)	1.48 (1.08-2.02)	1.10 (0.91-1.33)	1.16 (0.88-1.54)	1.05 (0.82-1.35)
Owned	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Area of residence						
Rural	1.12 (0.95-1.33)	1.03 (0.80-1.34)	1.19 (0.93-1.53)	0.88 (0.76-1.02)	0.79 (0.64-0.97)	0.99 (0.81-1.21)
Urban	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Identity of PMK						
Biological mother	0.96 (0.77-1.18)	1.10 (0.81-1.51)	0.83 (0.61-1.12)	0.99 (0.83-1.19)	1.03 (0.78-1.37)	0.94 (0.73-1.23)
Individual other than biological mother in at least 1 cycle	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Cohort						
Youth	1.75 (1.22-2.50)	1.13 (0.67-1.92)	2.52 (1.53-4.15)	0.93 (0.69-1.26)	0.88 (0.57-1.35)	0.97 (0.63-1.49)
Children	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Poor health, chronic condition, or asthma at baseline						
Yes ^c	1.70 (1.34-2.16)	1.44 (1.01-2.07)	2.09 (1.46-2.99)	4.09 (3.44-4.85)	4.72 (3.65-6.10)	3.59 (2.79-4.61)
No	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Chronic health condition in C6						
Yes	1.22 (1.34-1.96)	1.38 (1.03-1.85)	1.82 (1.42-2.35)			
No	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]			

(continued)

ers of disadvantage such as low income and lack of home ownership are accounted for. Repeated exposure to food insecurity appears to be particularly toxic. Interestingly, the effect of hunger on health appears to differ according to age, with effects apparent for general health among younger children but for chronic conditions and asthma among youth. Differences according to sex are also apparent, with adverse effects of hunger persisting for girls but not boys in stratified models. In their review of studies examining the effect of food insecurity on children's health and other outcomes, Cook and Frank⁶ also noted age and sex differences, with older girls appearing to be particularly vulnerable to the adverse effects of food insecurity. Further research is warranted to better understand how food insecurity might affect children differently depending on their age, sex, and other characteristics.

The mechanism by which childhood hunger negatively affects health is not well understood. Food insecurity has been associated with emotional and psychological stress among children, which could exert a negative effect on general health and contribute to heightened risk of chronic diseases.^{4,5,10,16-21} The NLSCY does not collect dietary intake data, making it difficult to ascertain whether

poor nutrition is a pathway by which food insecurity leads to poor health, particularly in the context of other studies indicating that children in food-insecure households may be protected from severe dietary compromise.²²⁻²⁴ While abnormal body weight may also negatively influence health and increase vulnerability to a range of chronic conditions, the existing research has not confirmed an association between food insecurity and body weight among children.^{13,25-29} Further research is needed to identify the pathways by which experiences of food insecurity and hunger may contribute to poor health outcomes. By controlling for baseline health and including indicators of household socioeconomic status in our models, we attempted to test the independent effect of severe food insecurity on health. However, it remains possible that food insecurity is only a marker of deprivation or of some other household characteristic that we either did not include in our models or that was unobserved in the data that predisposes children to both food insecurity and poor health.

This study has a number of limitations including the use of a single indicator to assess child hunger. Analysis of data from an earlier cycle of NLSCY¹¹ indicates that hunger, as assessed by this indicator, is associated with household sociodemographic characteristics that are also

Table 6. Odds of Poor Health Status, Diagnosed Chronic Condition, and Asthma in Cycle 6 in Relation to Ever Experiencing Hunger in Cycles 1 Through 5 in Combined Sample by Sex^a (continued)

Variable	Odds Ratio (95% Confidence Interval)		
	All Participants (n=9142)	Asthma	
		Boys (n=4632)	Girls (n=4510)
Hungry			
Ever hungry	1.85 (1.00-3.44)	1.57 (0.79-3.15)	2.23 (1.01-4.92)
Never hungry	0.95 (0.90-1.00)	0.93 (0.86-1.01)	0.96 (0.89-1.04)
Age, y			
Sex			
Female	0.91 (0.73-1.13)		
Male	1.00 [Reference]		
Average household income ^b	1.00 (1.00-1.00)	1.00 (1.00-1.00)	1.00 (0.99-1.01)
Adults, No.	1.05 (0.77-1.44)	1.19 (0.83-1.71)	0.96 (0.57-1.60)
Children, No.	0.84 (0.73-0.95)	0.95 (0.81-1.12)	0.72 (0.60-0.88)
Housing tenure	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Rented in at least 1 cycle	1.05 (0.80-1.39)	1.08 (0.72-1.62)	1.03 (0.72-1.50)
Owned	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Area of residence			
Rural	0.90 (0.74-1.09)	0.92 (0.71-1.20)	0.85 (0.64-1.13)
Urban	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Identity of PMK			
Biological mother	0.90 (0.68-1.19)	0.90 (0.59-1.38)	0.89 (0.63-1.28)
Individual other than biological mother in at least 1 cycle	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Cohort			
Youth	0.56 (0.37-0.83)	0.39 (0.23-0.67)	0.78 (0.41-1.51)
Children	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Poor health, chronic condition, or asthma at baseline			
Yes ^c	11.41 (8.53-15.26)	13.08 (8.46-20.23)	10.82 (7.14-16.41)
No	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]

Abbreviations: C6, cycle 6; PMK, person most knowledgeable about participant.

^aOdds ratios are adjusted for all other variables in the table.

^bOdds ratios for household income pertain to increments of CAD \$1000.

^cBaseline general health status was not stated for 133 children and 46 youth; baseline chronic condition status was not stated for 135 children and 48 youth; and baseline asthma status was not stated for 135 children and 47 youth. A dummy variable was included in the model to indicate not stated baseline health status for each outcome; the odds of poorer health outcomes in C6 among those whose baseline health status was not stated did not differ from the odds among those who did not have poor health at baseline.

predictive of measures of household food insecurity derived from a multi-item validated instrument.¹ Nonetheless, the availability of only a single indicator may have lead to misclassification of hunger status. Recent evidence suggests that such misclassification may result in an underestimation rather than an overestimation of the true effect of hunger on health (though that study made use of a multi-item measure).¹³ Further research using validated multi-item measures of food security would not only help to confirm our findings but could also enable examination of the association between varying levels of severity of food insecurity (eg, qualitative compromises in food consumption vs not having enough to eat) and health outcomes. For instance, one cross-sectional US study described a dose-response relationship between food insecurity and health among children, with higher odds of poor health as the severity of the food insecurity experience worsened.⁵

It should be noted that the observed effect of income on hunger in our models may have been blunted by the use of

average income across survey cycles, regressed in increments of CAD \$1000. An additional limitation of this study is our constrained statistical power owing to the rarity of child hunger, which hampered our efforts to assess the association between poor health and repeated exposure to hunger as well as to assess associations among boys and girls separately. In addition, this study included only children and youth for whom complete data were available during the 10-year period of interest. While the resulting sample may have underrepresented the most disadvantaged children and youth in Canada, the data set nevertheless includes children and youth with a range of characteristics found in the Canadian population. Further, neither longitudinal nor consistently collected (ie, using the same metric) information on food insecurity are currently available from any other Canadian data set.

This study is also limited by our reliance on parent/caregiver- and self-reported measures. The higher rates of hunger reported by youth compared with their parents or caregivers suggests differential reporting, consis-

tent with evidence on reporting of other data in the NLSCY.³⁰ For the most part, though, the inclusion of youth reports of hunger did not substantively change the associations we observed. Finally, we were limited to an examination of the health conditions included in the NLSCY questionnaire; future research should examine the association between childhood experiences of food insecurity and a broader range of health conditions, using objective indicators of health status where possible.

The findings of this study add to the literature showing that hunger is a serious risk factor for long-term poor health among children and youth, pointing to the relevance of severe food insecurity as an identifiable marker of vulnerability. Clinicians should familiarize themselves with risk factors for household food insecurity, which are largely related to economic disadvantage,^{1,3} and take steps to ensure that potentially vulnerable families receive available support.^{6,31} The findings also reinforce the need for advocacy for policy interventions to eliminate problems of poverty and food insecurity,^{6,31} which pose an unacceptable but remediable risk to children.

Accepted for Publication: February 24, 2010.

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Author Contributions: Dr Kirkpatrick had full access to all of the data in the study via the Statistics Canada Research Data Centre and takes responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Kirkpatrick, McIntyre, and Potestio. *Acquisition of data:* Kirkpatrick and McIntyre. *Analysis and interpretation of data:* Kirkpatrick and McIntyre. *Drafting of the manuscript:* Kirkpatrick and McIntyre. *Critical revision of the manuscript for important intellectual content:* Kirkpatrick, McIntyre, and Potestio. *Statistical analysis:* Kirkpatrick and McIntyre. *Administrative, technical, and material support:* McIntyre. *Study supervision:* McIntyre.

Financial Disclosures: None reported.

Funding/Support: The study was supported by the Alberta Heritage Foundation for Medical Research (Dr Kirkpatrick); the Canadian Institutes of Health Research (Dr McIntyre and Ms Potestio).

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