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A cross-sectional analysis of the association between household food insecurity and mental health conditions in children aged 5 to 11 years in Ontario

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What is already known on this topic - summarise the state of scientific knowledge on this subject before you did your study and why this study needed to be done

The association between household food insecurity and mental health diagnoses has been established in adolescents and adults however there is less evidence to support this association in younger children.

What this study adds - summarise what we now know as a result of this study that we did not know before

This study provides empirical evidence from a provincially representative sample of children aged 5 to 11 years that household food insecurity is associated with the presence of mental health conditions in a dose-response; meaning increasing severity of household food insecurity is associated with higher odds of mental health conditions.

How this study might affect research, practice or policy - summarise the implications of this study

Children living in households at any level of food insecurity are at increased risk of mental health conditions therefore public policies are needed to support families with young children both financially and through providing adequate mental health services in the community.

Abstract (word count: 250)

Background: Children living in food insecure households have poorer mental health outcomes compared to their food-secure peers; however, the relationship between severity of food insecurity and diagnosed mental health conditions in young children remains unknown. This study examined the association between household food insecurity and reported diagnosed mental health conditions among children aged 5-11 years in Ontario, Canada.

Methods: This study included 10,062 children aged 5-11 years living in Ontario, from the 2019 Canadian Health Survey on Children and Youth. We measured household food insecurity using the Household Food Security Survey Module. We measured diagnosed mental health conditions by parent/caregiver-report of physician-diagnosed anxiety, depression, autism spectrum disorder or attention-deficit/hyperactive disorder. We developed a multivariable logistic regression model to assess the association between severities of food insecurity and mental health, controlling for potentially confounding variables.

Results: 15.9% of children lived in households reporting some level of food insecurity (5.3% marginal, 7.4% moderate, and 3.3% severe). The prevalence of at least one diagnosed mental health condition in the same population was 9.6%. After adjusting for socio-demographic characteristics, children from marginal, moderate and severe food insecure households had a 1.57 (95% CI 0.97-2.55), 1.54 (95% CI 1.07-2.20) and 2.15 (95% CI 1.36-3.38) increased odds of having a diagnosed mental health condition, respectively.

Conclusion: Household food insecurity is associated with an increased presence of diagnosed mental health conditions in children. This study adds to the body of research showing that social and economic inequities, including household food insecurity, negatively impact the health of children.

Strengths and Limitations of this Study

- This study analyzed a large sample that was representative of the broader Ontario population of children aged 5 to 11, so results are generalizable across this population.
- This study was able to control for a variety of socio-demographic, family, and economic variables, including parent/caregiver mental health, which reduces the risk of confounding by another variable.
- This study relies on parent/caregiver reports of household food insecurity and child mental health, which may not reflect true levels of food insecurity and mental health diagnoses.
- This is a cross-sectional study and is therefore unable to determine whether household food insecurity causes increased mental health diagnoses among children.

Background (word count: 2785)

The prevalence of mental health conditions in children and youth is estimated at about 1 in 5 in Ontario, Canada.[1] Prior to COVID-19, previous studies showed increasing trends in the prevalence of some mental health conditions, particularly attention-deficit/hyperactive disorder (ADHD) in boys, and in the perceived need for professional help over the past 30 years.[2] Likewise, data from a nationally representative sample in Canada showed an increased prevalence of poor/fair mental health, anxiety and depression disorders, and increased mental health services since 2011.[3] Since 2020, emerging evidence indicates the COVID-19 pandemic likely exacerbated mental health issues in children and youth.[4]

Longitudinal research has found that mental health conditions in adolescence can have adverse health impacts in later life, such as lower self-reported general health and an increased likelihood of suicide in adulthood.[5,6] In addition to direct harms to individuals, there is a burden of mental illness on families and communities, including societal and economic costs.[7] To reduce the immediate and long-term impacts associated with these conditions, understanding key risk factors and preventing mental health conditions at an earlier age is a priority for public health.

A key social determinant of health is food insecurity, which is the lack of access to food as a result of financial struggles. The prevalence of food insecurity in Canada is high, particularly among households with children.[8] It is estimated that 1 in 4, or 1.8 million, children under the age of 18 in Canada lived in food insecure households in 2021.[9] Food insecurity in Canada is linked to compromised diets in children,[10] which negatively impacts child growth and development.[11] Beyond diet, exposure to adverse childhood experiences can trigger stress responses, which impact brain development and increase the risk of poor mental health through adulthood.[12]

Despite the high prevalence of food insecurity among children in Canada, there is limited Canadian research on the impacts of food insecurity on the mental health of young children. In longitudinal research, food insecurity in early childhood has been linked to psychosocial problems, depression, and suicide in subsequent years.[13,14] A recent cross-sectional study showed greater mental health care use among children living in food insecure households in Ontario.[15] No previous Canadian research has used a population-representative sample of young children to examine the relationship between severities of household food insecurity and diagnosed mental health conditions, while controlling for key confounding factors such as parent mental health.

We drew on the latest national population health survey of Canadian children, the 2019 Canadian Health Survey of Children and Youth (CHSCY),[16] to examine the association between household food insecurity and parent/caregiver reports of health professional diagnosed mental health conditions in children between the ages of 5 to 11 years in Ontario, while controlling for key factors of socioeconomic and family wellbeing. Given the personal, economic and social burden of mental illness in Canada and its increase in children and youth since the COVID-pandemic,[4] it is crucial to understand early intervention points that could be targeted through public health policies to help mitigate future burdens.

Methods

Study participants

We examined children 5 to 11 years, from Ontario, Canada, whose parent or caregiver responded to the 2019 CHSCY. The CHSCY is a national health survey run by Statistics Canada that represents 98% of Canada's children and youth aged 1 to 17 years as of January 31, 2019, who lived in private dwellings across 10 provinces and 3 territories.[16] The survey sampling frame excluded children living on First Nation reserves, other Indigenous settlements, foster homes, or children and youth who were institutionalized. Statistics Canada stratified the Ontario sample of CHSCY by sub-provincial geographic strata called Local Health Integration Networks, and by age group (1-4 years, 5-11 years, and 12-17 years). Participants completed the survey predominantly online (70.0%) while 26.4% completed it by phone with an interviewer; the remaining 3.6% completed the survey in both modalities.[17] For children younger than 12 years, the person most knowledgeable (PMK) of the sampled child completed the survey. PMKs were the birth parent for 97% of participants. This paper refers to a child's PMK as their "parent/caregiver". Parents/caregivers reported on multiple measures of their child's health and well-being. The response rate for Ontario children 5 to 11 years was 57.4%. To ensure national representation of the population in the survey sample, Statistics Canada provides weighted and bootstrapping values to conduct analyses. A total of 10,164 Ontario children aged 5 to 11 participated in CHSCY. We excluded children from our study sample if they were missing any exposure or outcome data used in the study, leaving a final analytic sample of 10,026 children.

Exposure: Household food insecurity

The main exposure was severity of household food insecurity, measured using the validated 18-question Household Food Security Survey Module (HFSSM).[18] Questions on the HFSSM measured a gradient of experiences related to food insecurity over the previous 12 months, from worrying about food running out to not eating for a whole day due to lack of money to buy more food.[16] We used established definitions to categorize children as food secure, marginally food insecure, moderately food insecure, or severely food insecure based on the number of affirmative answers on the HFSSM.[19] Food secure indicates no difficulty with income-related food access, marginally food insecure is defined as exactly one indication of difficulty with income-related food access (e.g., worried food would run out), moderately food insecure indicates compromise in the quality and/or the quantity of food consumed and lastly, severely food insecure indicates reduced food intake and disrupted eating patterns.[19] In sensitivity analyses we used a dichotomized exposure of food secure or food insecure (marginal, moderate, or severe).

Outcome: Diagnosed mental health conditions

The main outcome of this study was parent/caregiver-report of a mental health condition that is expected to last or has already lasted 6 months or more and was diagnosed by a health professional. We categorized children as having any diagnosed mental health condition if their parent/caregiver responded affirmatively to at least one of four questions related to the following long-term conditions: (1) "An anxiety disorder, such as a phobia or obsessive-compulsive disorder or a panic disorder"; (2) "A mood disorder such as depression, bipolar disorder, mania or dysthymia"; (3) "Attention deficit disorder or attention deficit hyperactivity disorder, also known as ADD or ADHD; or (4) "Autism spectrum disorder, also known as autism, autistic disorder, Asperger's disorder or pervasive developmental disorder". We performed sensitivity analyses to assess the association of food insecurity and two groups of mental health diagnoses separately: autism spectrum disorder and ADHD, and anxiety and mood disorder.

Covariates

We identified several potential confounding variables *a priori* in the existing literature based on their established association with household food insecurity or child health outcomes.[8,13,20-25] Covariates included sex at birth (male, female), age (years), highest parental educational attainment (high school or less, college/trades, bachelor's or more), household income adjusted for household size, parent/caregiver self-perceived mental health (excellent/very good, good, fair/poor), race and ethnic origin (White/non-racialized, Black, East Asian, Indigenous, Latin American, Other/Multiple, South Asian, Southeast Asian/Filipino, West Asian/Arab), immigration status (non-immigrant, immigrant/non-permanent resident), and parent divorce/separation (yes, no).

Statistical Analysis

We calculated weighted prevalence of mental health conditions and socio-demographic characteristics across food security categories and performed Chi-squared tests for categorical variables and t-tests for continuous variables to assess statistically significant differences between covariate groups.

We created multivariable logistic regression models to estimate the association between food insecurity and mental health conditions, adjusting for age, sex, household income divided by the square root of the number of household members to adjust for household size,[26] highest level of parental educational attainment, parent self-perceived mental health, race or ethnic origin and Indigenous identity, child immigration status, and parent/caregiver divorce or separation.

To account for the complex survey design, in all analyses we used PROC SURVEY commands in SAS with bootstrap weights and bootstrap replications (n = 1000) provided by Statistics Canada. We assessed collinearity using variance inflation factors and none exceeded a value of 2, indicating no significant collinearity. We conducted sensitivity analyses consisting of separate models to analyze mood and anxiety disorders only, ADHD and ASD only, and with food security collapsed into two categories: food secure versus not food secure. We conducted all analyses using SAS Enterprise Guide (V8.2).

Ethics Approval

This study was approved by the Ethics Review Board of Public Health Ontario.

Results

The total sample of Ontario children between the ages of 5 to 11 years included in this study was 10,026. The prevalence of household food insecurity in our sample was 15.9%; 5.3% were marginally food insecure, 7.4% were moderately food insecure, and 3.2% were severely food insecure. The prevalence of any parent/caregiver-reported diagnosed mental health condition in our sample was 9.6% (7.4% reported a single condition, 2.2% reported two or more conditions); 2.5% had ASD, 6.2% had ADHD, 3.4% had anxiety or depression (Figure 1).

There were significant differences in most socio-demographic characteristics across food insecurity categories (Table 1). Children in households with higher levels of food insecurity tended to have lower household income, lower levels of parent education, more likely to be from a racialized group or identify as Indigenous, more likely to have a parent/caregiver with fair or poor mental health, and more likely to have experienced parent/caregiver divorce or separation. There were no significant differences in age,

sex, or child's immigration status. Children whose parents/caregivers had a bachelor's degree had lower food insecurity compared to those who reported having a high school diploma or a college/trades certificate. Parents/caregivers who reported excellent or very good mental health also had lower severity of household food insecurity (Table 1).

Figure 1 shows the prevalence of health professional diagnosed mental health conditions by household food insecurity status. The survey-weighted percentage of children aged 5 to 11 with a mental health diagnosis was 8.2% in food secure households, 12.9% in marginally, 14.7% in moderately and 26.1% in severely food insecure households.

In the unadjusted model, household food insecurity was dose-dependently associated with increased odds of having a mental health condition (Table 2). After adjusting for confounding factors, a significant dose-dependent relationship remained for children living in moderately and severely food insecure households, who had a 1.54 (95% CI 1.07-2.20) and 2.15 (95% CI 1.36-3.38) higher risk of having any diagnosed mental health condition, respectively, compared to children living in food secure households (Table 2).

Sensitivity analysis where mood and anxiety disorders were analyzed separately showed a stronger association than both the primary analysis and the sensitivity analysis of ASD and ADHD analyzed separately, with children in severely food insecure households having 3.06 (95% CI, 1.59-5.91) higher odds of a diagnosed mood or anxiety disorder (Supplementary Table 1). Sensitivity analysis using two levels of food security, food secure and food insecure, showed associations similar to those between moderate household food insecurity and diagnosed mental health conditions (Supplementary Table 2).

Discussion

This study examined the association between household food insecurity and diagnosed mental health conditions among children 5 to 11 years using a provincially representative sample of children in Ontario. We found that children living in food insecure households were more likely to have a diagnosed mental health condition, including anxiety, mood disorders, ASD and ADHD, independent of sociodemographic and parent/caregiver characteristics. Household food insecurity was dose-dependently associated with a child's likelihood of having a diagnosed mental health condition, speaking to the importance of examining food insecurity by severity when possible. After adjusting for important confounders including income and parent/caregiver mental health, children in severely food insecure households were more than twice as likely to have a diagnosed mental health condition compared to children in food secure households.

Previous studies found increased odds of negative mental health outcomes among children and youth living in households experiencing food insecurity. Anderson et al. identified associations between food security and health care visits for a mental disorder among Canadian children aged 1-17.[15] This study showed increasing prevalence of mental health service use with increasing food insecurity severity, similar to our study. While some sensitivity analyses conducted by Anderson et al. were comparable to our analyses, our study identified stronger associations between food security and child mental health. One explanation may be limitations associated with using physician billing codes, such as miscoding the primary reason for the patient visit, particularly for outpatient visits, as well as not capturing other health professional identified diagnoses, such as those paid for through private insurance or out of

pocket.[27] Other potential explanations may be our data are more recent, more representative of the broader population, or because of our narrower focus on children aged 5-11 years. Men et al. identified relationships between food security and mental health among Canadian youth aged 12-24.[28] Similar to our findings among children 5-11 years old, they showed a dose-response relationship between severity of food insecurity and mental health, where the odds of presence of diagnosed mental health conditions increased as the severity of household food insecurity increased among adolescents and adults.[28]

Household food insecurity can impact a child's mental health through a number of mechanisms.[13] Children from severely food insecure households face reduced quality, quantity, and frequency of meals which may directly impact behavioural difficulties and mental health conditions.[29] An indirect pathway may be through parental well-being where parents and caregivers experiencing food insecurity may reduce sensitive and responsive parenting from the chronic financial and emotional stress of acquiring food, which can negatively impact the child's overall mental health.[29] This suggests that even if children are not themselves experiencing disrupted eating or hunger, the uncertainty around food affordability and food availability in the family is enough to precipitate mental health conditions.

Our sensitivity analyses showed a stronger association between food insecurity and diagnosed mood and anxiety disorders, compared to the association with ASD and ADHD. This may be because of differing biological and psychosocial mechanisms underlying the associations between food insecurity and neurodevelopmental disorders compared to mood and anxiety disorders. There may also be temporal differences in exposure to food insecurity and the likelihood of developing a mood/anxiety disorder compared to a neurodevelopmental disorder. Macronutrient deficiencies affecting neurotransmitters and neuropsychiatric regulation in the early years may have effects on brain development and subsequent mental health problems.[30] Additionally, psychosocial and environmental effects including parental stress may contribute to the association between food insecurity and child mental health.[30]

One major strength of this study was examining the dose-response relationship of food insecurity with parent/caregiver-reported diagnosed mental health conditions. Additionally, this is one of the few studies in the literature that analyzes mental health among young children between 5 to 11 years in Canada. The survey used for these analyses, CHSCY, is sampled and weighted to be representative of the child population in Canada. Additionally, food insecurity was captured using the HFSSM, which is well-validated as the primary measurement tool of food insecurity in Canada. Given the breadth of data collected in the CHSCY, we were also able to control for multiple sociodemographic, family, and economic factors in our analysis, including parent/caregiver mental health, which is an important confounder of the relationship between food security and child mental health.

Certain limitations should be considered when interpreting the results. The study used a cross-sectional design and is therefore unable to determine causality or to detangle the potential bidirectional relationship between food insecurity and child mental health. For instance, poor child mental health may worsen a family's food insecurity by depleting scarce financial and time resources. Additionally, the study relies on parental reports of both household food insecurity and health professional-diagnosed mental health conditions and is therefore at risk of information biases such as recall and social desirability biases. Further, parental reports have been shown to underestimate children's experience of food insecurity, compared to child reports.[31] To whatever degree this bias was present in our study, it would underestimate food insecurity and likely bias our results towards the null. It is also important to

note some limitations of the CHSCY survey. Although the CHSCY data provides nationally representative data, the 2019 response rate to this survey cycle was only 57.4% for children 5 to 11 years and 51.8% overall.[17] This may introduce some selection bias in the population surveyed, although the impact on our findings, if any, is unclear given the correcting use of bootstrap weights and replicates, and existing evidence that response rates on health surveys is not related to nonresponse bias or data representativeness.[32]

Conclusion

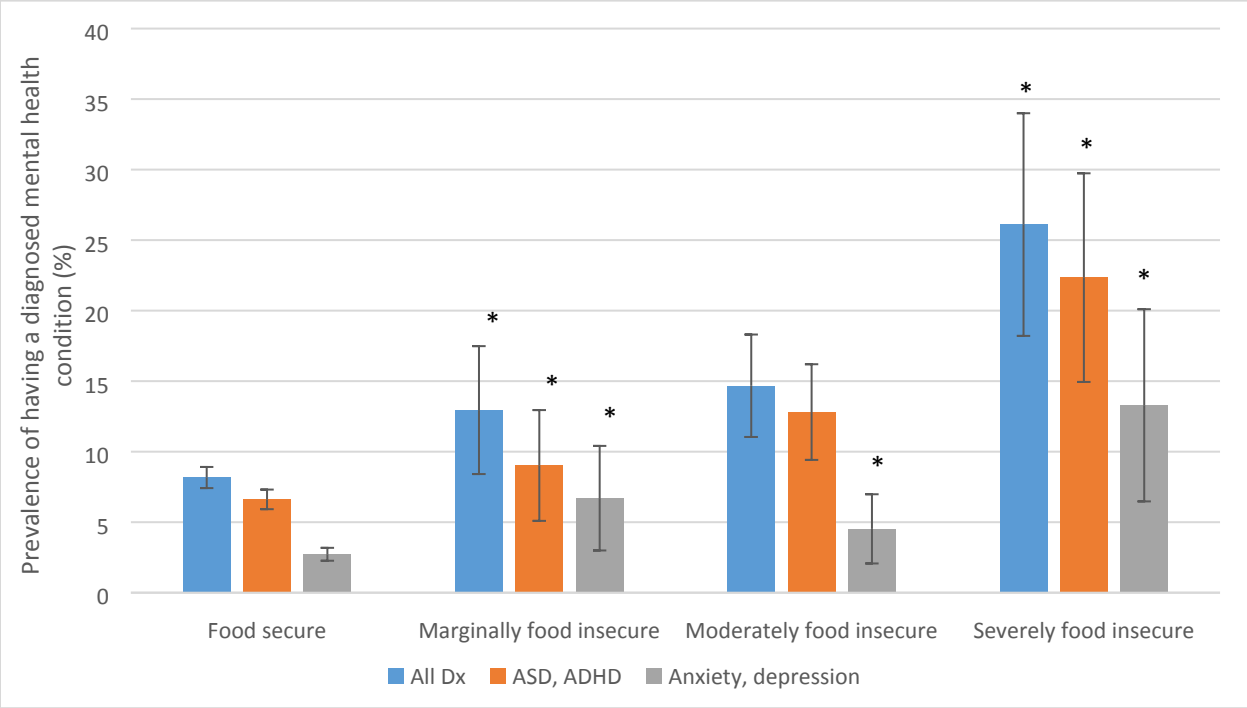
This study found that Ontario children aged 5-11 who live in severely food insecure households are twice as likely to have been diagnosed with a mental health condition than children in food secure households. Compounded by the increases in child mental health conditions and rising food insecurity rates, both food insecurity and mental health are public health priorities. This study supports the need to implement policies that are focused on creating sustainable systems to alleviate the burden of food insecurity on mental health.

Tables and Figures

Table 1: Characteristics of study population of children age 5-11, by food security status; Ontario, 2019

Characteristics	Total	Food secure	Marginally food insecure	Moderately food insecure	Severely food insecure	P-value for differences across groups
Age (Mean years)	8.0	8.0	7.8	8.0	8.0	0.20
Sex						0.33
Female	49.0	48.8	54.5	48.5	47.1	
Male	51.0	51.2	45.5	51.5	52.9	
Household income adjusted for household size (Mean dollars)	54,203	59,325	30,657	26,462	23,147	
Highest parental education						<.0001
High school or less	13.9	11.6	22.8	25.5	32.8	
College/Trades	36.2	34.2	45.9	47.1	48.9	
Bachelor's or more	49.9	54.3	31.3	27.5	18.3	
Race and ethnic origin						<.0001
Black	7.3	5.7	11.1	18.0	18.8	
East Asian	5.9	6.5	3.0	3.7	0.6	
Latin American	1.1	1.1	1.7	0.9	0.6	
Other/Multiple	3.1	2.7	8.8	3.6	4.1	
South Asian	11.3	11.9	9.6	9.3	3.6	
Southeast Asian/Filipino	4.1	4.0	4.6	6.6	2.0	
Indigenous	3.2	2.6	4.9	4.6	13.8	
West Asian/Arab	3.6	3.4	5.6	4.5	3.0	
White/non-racialized	60.2	62.1	50.7	48.7	53.6	
Child immigration status						0.30
Immigrant/non-perm resident	9.5	9.5	11.5	9.9	5.7	
Not immigrant/non-perm resident	90.5	90.5	88.5	90.1	94.3	
Experience parental separation						<.0001
Experienced separation/divorce	16.3	13.4	25.0	29.4	47.5	
Never experienced separation/divorce	83.7	86.6	75.0	70.6	52.5	
PMK mental health						<.0001
Excellent/very good	71.0	74.0	64.8	56.5	38.0	
Good	23.0	21.5	25.9	32.5	36.3	
Fair/poor	5.9	4.5	9.3	11.0	25.7	

Figure 1: Prevalence of diagnosed mental health conditions in children 5-11, by food security status; Ontario, 2019



Dx = Diagnosis, ASD = Autism Spectrum Disorder, ADHD = Attention Deficit Hyperactivity Disorder
*Interpret estimate with caution due to a Coefficient of Variation greater than 15%

Table 2: Unadjusted and adjusted logistic regression models of the association between household food insecurity status and any diagnosed mental health condition

Variable	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Household Food Security		
Food Secure	REF	REF
Marginally Food Insecure	1.67 (1.09, 2.57)	1.57 (0.97, 2.55)
Moderately Food Insecure	1.93 (1.42, 2.63)	1.54 (1.07, 2.20)
Severely Food Insecure	3.97 (2.60, 6.07)	2.15 (1.36, 3.38)
Age (years)	1.23 (1.17, 1.29)	1.24 (1.18, 1.30)
Sex		
Female	REF	REF
Male	2.29 (1.87, 2.81)	2.44 (1.99, 3.00)
Household Income (adjusted for household size, per $5000)	0.97 (0.95, 0.99)	0.99 (0.97, 1.01)
Highest Level Parent Education		
High school or less	REF	REF
College/Trades	1.03 (0.78, 1.37)	1.18 (0.88, 1.59)
University or more	0.64 (0.48, 0.86)	1.07 (0.78, 1.45)
Parent's Mental Health Status		
Excellent/Very good	REF	REF
Good	2.31 (1.88, 2.84)	1.91 (1.53, 2.40)
Fair/Poor	4.43 (3.31, 5.95)	3.41 (2.47, 4.71)
Race and ethnic origin		
White/non-racialized	REF	REF
Black	1.05 (0.69, 1.59)	0.90 (0.55, 1.45)
East Asian	0.46 (0.27, 0.79)	0.57 (0.33, 0.98)
Indigenous	2.23 (1.52, 3.28)	1.63 (1.07, 2.48)
Latin American	0.72 (0.27, 1.95)	0.80 (0.30, 2.13)
Other/Multiple	0.61 (0.32, 1.13)	0.54 (0.28, 1.04)
South Asian	0.30 (0.19, 0.48)	0.42 (0.26, 0.68)
Southeast Asian/Filipino	0.30 (0.15, 0.59)	0.36 (0.17, 0.75)
West Asian/Arab	0.40 (0.17, 0.91)	0.49 (0.22, 1.11)
Immigration Status		
Non-immigrant	REF	REF
Immigrant/non-permanent resident	0.41 (0.27, 0.65)	0.71 (0.44, 1.12)
Divorce/Separation		
No	REF	REF
Yes	2.46 (1.98, 3.06)	1.55 (1.21, 1.98)

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Supplementary Table 1a: Unadjusted and adjusted logistic regression models of the association between household food insecurity status and a diagnosed mood or anxiety disorder

Variable	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Household Food Security		
Food Secure	REF	REF
Marginally Food Insecure	2.57 (1.31, 5.02)	2.46 (1.15, 5.23)
Moderately Food Insecure	1.69 (0.91, 3.16)	1.38 (0.71, 2.70)
Severely Food Insecure	5.47 (2.87, 10.4)	3.06 (1.59, 5.91)
Age (years)	1.31 (1.21, 1.43)	1.32 (1.22, 1.44)
Sex		
Female	REF	REF
Male	1.15 (0.83, 1.59)	1.16 (0.83, 1.61)
Household Income (adjusted for household size, per $5000)	0.98 (0.94, 1.02)	1.00 (0.96, 1.03)
Highest Level Parent Education		
High school or less	REF	REF
College/Trades	1.01 (0.61, 1.70)	1.21 (0.69, 2.11)
University or more	0.71 (0.42, 1.21)	1.49 (0.82, 2.71)
Parent's Mental Health Status		
Excellent/Very good	REF	REF
Good	2.97 (2.06, 4.28)	2.25 (1.50, 3.37)
Fair/Poor	6.19 (3.77, 10.2)	4.03 (2.41, 6.76)
Race and ethnic origin		
White/non-racialized	REF	REF
Black	0.45 (0.14, 1.41)	0.33 (0.10, 1.13)
East Asian	0.28 (0.10, 0.81)	0.35 (0.12, 1.02)
Indigenous	2.32 (1.25, 4.31)	1.59 (0.83, 3.03)
Latin American	0.54 (0.06, 5.01)	0.57 (0.06, 5.43)
Other/Multiple	0.43 (0.04, 4.86)	0.40 (0.03, 4.62)
South Asian	0.10 (0.02, 0.57)	0.13 (0.02, 0.81)
Southeast Asian/Filipino	0.33 (0.05, 2.02)	0.42 (0.06, 2.72)
West Asian/Arab	0.31 (0.04, 2.14)	0.42 (0.06, 2.87)
Immigration Status		
Non-immigrant	REF	REF
Immigrant/non-permanent resident	0.35 (0.18, 0.69)	0.87 (0.43, 1.76)
Divorce/Separation		
No	REF	REF
Yes	3.28 (2.31, 4.66)	2.02 (1.34, 3.05)

Supplementary Table 1b: Unadjusted and adjusted logistic regression models of the association between household food insecurity status and diagnosed autism spectrum disorder or attention deficit hyperactivity disorder

Variable	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Household Food Security		
Food Secure	REF	REF
Marginally Food Insecure	1.40 (0.84, 2.33)	1.25 (0.71, 2.20)
Moderately Food Insecure	2.07 (1.49, 2.88)	1.57 (1.07, 2.29)
Severely Food Insecure	4.06 (2.61, 6.32)	2.06 (1.26, 3.37)
Age (years)	1.19 (1.14, 1.26)	1.21 (1.15, 1.27)
Sex		
Female	REF	REF
Male	3.31 (2.60, 4.22)	3.56 (2.80, 4.54)
Household Income (adjusted for household size, per $5000)	0.95 (0.93, 0.98)	0.97 (0.95, 1.00)
Highest Level Parent Education		
High school or less	REF	REF
College/Trades	0.97 (0.72, 1.32)	1.10 (0.80, 1.52)
University or more	0.56 (0.41, 0.77)	0.95 (0.66, 1.35)
Parent's Mental Health Status		
Excellent/Very good	REF	REF
Good	2.13 (1.69, 2.67)	1.75 (1.36, 2.26)
Fair/Poor	4.39 (3.20, 6.03)	3.41 (2.41, 4.83)
Race and ethnic origin		
White/non-racialized	REF	REF
Black	1.17 (0.76, 1.78)	0.98 (0.60, 1.60)
East Asian	0.46 (0.25, 0.84)	0.57 (0.31, 1.06)
Indigenous	1.96 (1.29, 2.99)	1.37 (0.86, 2.19)
Latin American	0.62 (0.15, 2.57)	0.72 (0.18, 2.91)
Other/Multiple	0.60 (0.31, 1.16)	0.50 (0.26, 0.99)
South Asian	0.34 (0.21, 0.54)	0.47 (0.28, 0.79)
Southeast Asian/Filipino	0.25 (0.13, 0.48)	0.29 (0.15, 0.59)
West Asian/Arab	0.40 (0.15, 1.02)	0.46 (0.18, 1.17)
Immigration Status		
Non-immigrant	REF	REF
Immigrant/non-permanent resident	0.39 (0.23, 0.66)	0.63 (0.37, 1.08)
Divorce/Separation		
No	REF	REF
Yes	2.35 (1.86, 2.97)	1.43 (1.09, 1.86)

Supplementary Table 2: Unadjusted and adjusted logistic regression models of the association between household food insecurity and any diagnosed mental health condition

Variable	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Household Food Security		
Food Secure	REF	REF
Food Insecure (marginal, moderate, or severe)	2.70 (1.81, 4.01)	1.68 (1.28, 2.21)
Age (years)	1.31 (1.21, 1.43)	1.24 (1.18, 1.30)
Sex		
Female	REF	REF
Male	2.29 (1.87, 2.81)	2.45 (1.99, 3.02)
Household Income (adjusted for household size, per $5000)	0.97 (0.95, 0.99)	0.99 (0.97, 1.01)
Highest Level Parent Education		
High school or less	REF	REF
College/Trades	1.03 (0.78, 1.37)	1.17 (0.87, 1.58)
University or more	0.64 (0.48, 0.86)	1.06 (0.78, 1.44)
Parent's Mental Health Status		
Excellent/Very good	REF	REF
Good	2.31 (1.88, 2.84)	1.92 (1.53, 2.41)
Fair/Poor	4.43 (3.31, 5.95)	3.49 (2.52, 4.83)
Race and ethnic origin		
White/non-racialized	REF	REF
Black	1.05 (0.69, 1.59)	0.90 (0.55, 1.45)
East Asian	0.46 (0.27, 0.79)	0.56 (0.32, 0.98)
Indigenous	2.23 (1.52, 3.28)	1.66 (1.09, 2.52)
Latin American	0.72 (0.27, 1.95)	0.79 (0.30, 2.10)
Other/Multiple	0.61 (0.32, 1.13)	0.53 (0.27, 1.03)
South Asian	0.30 (0.19, 0.48)	0.42 (0.26, 0.68)
Southeast Asian/Filipino	0.30 (0.15, 0.59)	0.36 (0.17, 0.74)
West Asian/Arab	0.40 (0.17, 0.91)	0.49 (0.22, 1.11)
Immigration Status		
Non-immigrant	REF	REF
Immigrant/non-permanent resident	0.41 (0.27, 0.65)	0.71 (0.45, 1.12)
Divorce/Separation		
No	REF	REF
Yes	2.46 (1.98, 3.06)	1.56 (1.22, 2.00)

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4,5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4,5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	4
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	5
		(*e*) Describe any sensitivity analyses	5
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	4
		(b) Give reasons for non-participation at each stage	4
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5,9
		(b) Indicate number of participants with missing data for each variable of interest	N/A
Outcome data	15*	Report numbers of outcome events or summary measures	10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11

		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	6
Discussion			
Key results	18	Summarise key results with reference to study objectives	6
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	7
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	6-8
Generalisability	21	Discuss the generalisability (external validity) of the study results	7,8
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	1

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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A cross-sectional analysis of the association between household food insecurity and mental health conditions in children aged 5 to 11 years in Canada

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Abstract (word count: 254)

Background: Children living in food insecure households have poorer mental health outcomes compared to their food-secure peers; however, the relationship between severity of food insecurity and diagnosed mental health conditions in young children remains unknown. This study examined the association between household food insecurity and reported diagnosed mental health conditions among children aged 5-11 years in Canada.

Methods: This study included 16,216 children aged 5-11 years living in Canada, from the 2019 Canadian Health Survey on Children and Youth. We measured household food insecurity using the Household Food Security Survey Module. We measured diagnosed mental health conditions by parent/caregiver-report of physician-diagnosed anxiety, depression, autism spectrum disorder or attention-deficit/hyperactive disorder. We developed a multivariable logistic regression model to assess the association between severities of food insecurity and mental health, controlling for potentially confounding variables.

Results: 17.0% of children lived in households reporting some level of food insecurity (5.4% marginal, 8.0% moderate, and 3.6% severe). The prevalence of at least one diagnosed mental health condition in the same population was 10.9%. After adjusting for socio-demographic characteristics, children from marginal, moderate and severe food insecure households had a 1.39 (95% CI 0.99-1.97), 1.46 (95% CI 1.13-1.89) and 1.67 (95% CI 1.18-2.35) increased odds of having a diagnosed mental health condition, respectively.

Conclusion: Household food insecurity is associated with an increased presence of diagnosed mental health conditions in children ages 5 to 11 years. This study adds to the body of research showing that social and economic inequities, including household food insecurity, negatively impact the health of children.

Strengths and Limitations of this Study

- This study analyzed a large sample that was representative of the broader Canada population of children aged 5 to 11, so results are generalizable across this population.
- This study was able to control for a variety of socio-demographic, family, and economic variables, including parent/caregiver mental health, which reduces the risk of confounding by another variable.
- This study relies on parent/caregiver reports of household food insecurity and child mental health, which may not reflect true levels of food insecurity and mental health diagnoses.
- This is a cross-sectional study and is therefore unable to determine whether household food insecurity causes increased mental health diagnoses among children.

Background (word count: 3267)

The prevalence of mental health conditions in children and youth is estimated at about 1 in 5 in Canada.[1] Prior to COVID-19, previous studies showed increasing trends in the prevalence of some mental health conditions and developmental disorders, particularly attention-deficit/hyperactive disorder (ADHD) in boys, and in the perceived need for professional help over the past 30 years.[2] Likewise, data from a nationally representative sample in Canada showed an increased prevalence of poor/fair mental health, anxiety and depression disorders, and increased mental health services since 2011.[3] Since 2020, emerging evidence indicates the COVID-19 pandemic likely exacerbated mental health issues in children and youth.[4]

Longitudinal research has found that mental health conditions in adolescence can have adverse health impacts in later life, such as lower self-reported general health and an increased likelihood of suicide in adulthood.[5,6] In addition to direct harms to individuals, there is a burden of mental illness on families and communities, including societal and economic costs.[7] To reduce the immediate and long-term impacts associated with these conditions, understanding key risk factors and preventing mental health conditions at an earlier age is a priority for public health.

A key social determinant of health is food insecurity. Broadly defined, food insecurity is the inability or uncertainty about being able to acquire or consume an adequate diet quality or sufficient quantity of food in socially acceptable ways.[8] In Canada, food insecurity is measured and monitored as a household's financial ability to access adequate food, and encompasses a range of experiences from worrying about running out of food before there is money to buy more, to compromising on the quality or quantity of food due to lack of money, to not eating for whole days due to lack of money to buy food. The prevalence of household food insecurity in Canada is high, particularly among households with children.[9] It is estimated that 1 in 4, or 1.8 million, children under the age of 18 in Canada lived in food insecure households in 2022.[9,10] Food insecurity in Canada is linked to compromised diets in children,[11] which negatively impacts child growth and development.[12] Beyond diet, exposure to adverse childhood experiences can trigger stress responses, which impact brain development and increase the risk of poor mental health through adulthood.[13]

Despite the high prevalence of food insecurity among children in Canada, there is limited Canadian research on the impacts of food insecurity on the mental health of young children. In longitudinal research, food insecurity in early childhood has been linked to psychosocial problems, depression, and suicide in subsequent years.[14,15] A recent cross-sectional study showed greater mental health care use among children living in food insecure households in Ontario.[16] Another recent cross-sectional study using population survey data shows poorer mental health among food insecure Canadian children and adolescents.[17] However, this study classifies children as food insecure solely based on the child-referenced items in the household food insecurity questionnaire, which arguably misclassifies many children living in food insecure households (as indicated by an affirmative response to at least one adult-referenced item) as 'food secure'. Research from the US has shown families of individuals with autism spectrum disorder or ADHD experience higher levels of food insecurity due to multiple social and biological mechanisms.[18,19] For example, parents of children with autism spectrum disorder spend more money in out-of-pocket health care expenses than those without autism spectrum disorder, impacting household finances.[20] No previous Canadian research has used a population-representative sample of young children to examine the relationship between severities of household food insecurity and

diagnosed mental health conditions, while controlling for key confounding factors such as parent mental health.

We drew on the latest national population health survey of Canadian children, the 2019 Canadian Health Survey of Children and Youth (CHSCY),[21] to examine the association between household food insecurity and parent/caregiver reports of health professional diagnosed mental health conditions in children between the ages of 5 to 11 years, while controlling for key factors of socioeconomic and family wellbeing. This study builds on prior knowledge by examining a younger age group, multiple levels of household food insecurity and the association with specific mental health conditions and developmental disorders. Given the personal, economic and social burden of mental illness in Canada and its increase in children and youth since the COVID-pandemic,[4] it is crucial to understand early intervention points that could be targeted through public health policies to help mitigate future burdens.

Methods

Study participants

We examined Canadian children 5 to 11 years, whose parent or caregiver responded to the 2019 CHSCY. The CHSCY is a national health survey run by Statistics Canada that represents 98% of Canada's children and youth aged 1 to 17 years as of January 31, 2019, who lived in private dwellings across Canada's 10 provinces and 3 territories.[21] The survey sampling frame excluded children living on First Nation reserves, other Indigenous settlements, foster homes, or children and youth who were institutionalized. Statistics Canada stratified the CHSCY population sample by sub-provincial geographic strata, sex, and age group (1-4 years, 5-11 years, and 12-17 years). Participants completed the survey predominantly online (70.0%) while 26.4% completed it by phone with an interviewer; the remaining 3.6% completed the survey in both modalities.[22] For children younger than 12 years, the person most knowledgeable (PMK) of the sampled child completed the survey. PMKs were the birth parent for 97% of participants. This paper refers to a child's PMK as their "parent/caregiver". Parents/caregivers reported on multiple measures of their child's health and well-being. The response rate for children 5 to 11 years was 57.8%. To ensure national representation of the population in the survey sample, Statistics Canada provides weighted and bootstrapping values to conduct analyses. A total of 16,694 children aged 5 to 11 participated in CHSCY. We excluded children from our study sample if they were missing any exposure or outcome data used in the study, leaving a final analytic sample of 16,216 children.

Exposure: Household food insecurity

The main exposure was severity of household food insecurity, measured using the validated 18-question Household Food Security Survey Module (HFSSM).[23] Questions on the HFSSM measured a gradient of experiences related to food insecurity over the previous 12 months, from worrying about food running out to not eating for a whole day due to lack of money to buy more food.[21] We used established definitions to categorize children as food secure, marginally food insecure, moderately food insecure, or severely food insecure based on the number of affirmative answers on the HFSSM.[24] Food secure indicates no difficulty with income-related food access, marginally food insecure is defined as exactly one indication of difficulty with income-related food access (e.g., worried food would run out), moderately food insecure indicates compromise in the quality and/or the quantity of food consumed and lastly, severely food insecure indicates reduced food intake and disrupted eating patterns.[24] In

sensitivity analyses we used a dichotomized exposure of food secure or food insecure (marginal, moderate, or severe).

Outcome: Diagnosed mental health conditions

The primary outcome of this study was parent/caregiver-report of a mental health condition that is expected to last or has already lasted 6 months or more and was diagnosed by a health professional. We categorized children as having any diagnosed mental health condition if their parent/caregiver responded affirmatively to at least one of four questions related to the following long-term conditions: (1) "An anxiety disorder, such as a phobia or obsessive-compulsive disorder or a panic disorder"; (2) "A mood disorder such as depression, bipolar disorder, mania or dysthymia"; (3) "Attention deficit disorder or attention deficit hyperactivity disorder, also known as ADD or ADHD; or (4) "Autism spectrum disorder, also known as autism, autistic disorder, Asperger's disorder or pervasive developmental disorder". We also analyzed three secondary outcomes. We assessed the associations between food insecurity and autism spectrum disorder and ADHD as two separate outcomes. We assessed anxiety disorder and mood disorder grouped together because small sample sizes of children with these outcomes precluded analyzing them separately. As a sensitivity analysis, we combined the three levels of food insecurity together to create a dichotomous exposure variable and analyzed its association with the primary outcome: having any of the four mental health outcomes.

Covariates

We identified several potential confounding variables *a priori* in the existing literature based on their established association with household food insecurity or child health outcomes.[9,14,25-30] Covariates included sex at birth (male, female), age (years), highest parental educational attainment (high school or less, college/trades, bachelor's or more), parent/caregiver-reported household income adjusted for household size, parent/caregiver self-perceived mental health (excellent/very good, good, fair/poor), race and ethnic origin (White/non-racialized, Black, East Asian, Indigenous, Latin American, Other/Multiple, South Asian, Southeast Asian/Filipino, West Asian/Arab), immigration status (non-immigrant, immigrant/non-permanent resident), and parent divorce/separation (yes, no).

Statistical Analysis

We calculated weighted prevalence of mental health conditions and socio-demographic characteristics across food security categories and performed Chi-squared tests for categorical variables and t-tests for continuous variables to assess statistically significant differences between covariate groups.

We created bivariate logistic regression models to estimate the unadjusted associations between each covariate and the mental health conditions. We created multivariable logistic regression models to estimate the association between food insecurity and mental health conditions, adjusting for age, sex, household income divided by the square root of the number of household members to adjust for household size,[31] highest level of parental educational attainment, parent self-perceived mental health, race or ethnic origin and Indigenous identity, child immigration status, and parent/caregiver divorce or separation.

To account for the complex survey design, in all analyses we used PROC SURVEY commands in SAS with bootstrap weights and bootstrap replications (n = 1000) provided by Statistics Canada. We assessed collinearity using variance inflation factors and none exceeded a value of 2, indicating no significant

collinearity. We conducted a sensitivity analysis with food security collapsed into two categories: food secure versus not food secure. We conducted all analyses using SAS Enterprise Guide (V8.2).

Ethics Approval

This study was approved by the Ethics Review Board of Public Health Ontario. Our study is a secondary analysis of de-identified data that was previously collected by Statistics Canada. Informed consent was obtained by Statistics Canada, the federal agency that oversaw survey procedures and data collection for CHSCY. De-identified data was provided to Public Health Ontario confidentially through the Ontario Ministry of Health.

Patient and Public Involvement

This study uses secondary data from a survey previously conducted by Statistics Canada. All participant identifiers had been removed from the data, so it was not possible to involve participants in the development of the research question, outcome measures, study design, conduct of the study, or dissemination of the results.

Results

The total sample of Canadian children between the ages of 5 to 11 years included in this study was 16,216. The prevalence of household food insecurity in our sample was 17.0%; 5.4% were marginally food insecure, 8.0% were moderately food insecure, and 3.6% were severely food insecure. The prevalence of any parent/caregiver-reported diagnosed mental health condition in our sample was 10.9% (8.4% reported a single condition, 2.5% reported two or more conditions); 2.5% had ASD, 7.6% had ADHD, 3.4% had anxiety or depression (Figure 1).

There were significant differences in most socio-demographic characteristics across food insecurity categories (Table 1). Children in households with higher levels of food insecurity tended to have lower household income, lower levels of parent education, more likely to identify as Black or Indigenous, were more likely to be born in Canada, were more likely to have a parent/caregiver with fair or poor mental health, and were more likely to have experienced parent/caregiver divorce or separation (Table 1).. There were no significant differences in age or sex.

Figure 1 shows the prevalence of health professional diagnosed mental health conditions by household food insecurity status. The survey-weighted percentage of children aged 5 to 11 with a mental health diagnosis was 9.5% in food secure households, 13.5% in marginally, 17.3% in moderately and 24.8% in severely food insecure households.

In the unadjusted model of our primary outcome, household food insecurity was dose-dependently associated with increased odds of having a mental health condition (Table 2). After adjusting for confounding factors, the effect sizes and the dose-dependent relationship were diminished, yet a significant association remained for children living in moderately and severely food insecure households, who had a 1.46 (95% CI 1.13-1.89) and 1.67 (95% CI 1.18-2.35) higher risk of having any diagnosed mental health condition, respectively, compared to children living in food secure households (Table 2).

Regarding the secondary outcomes, in the unadjusted analysis of mood and/or anxiety disorders, each level of food insecurity was associated with over twice the odds of a mood and/or anxiety disorder.

However, adjusting for confounding factors attenuated each association, especially the association with severe food insecurity, which was no longer statistically significant (Table 3). In the analysis of ADHD, adjusting for confounding factors also attenuated the associations between each level of food insecurity and diagnosed ADHD, although in this case only participants with severe food insecurity remained significantly more likely to have ADHD (Table 4). Similar to the other outcomes, the analysis of autism spectrum disorder showed that adjusting for confounding factors attenuated the associations between each level of food insecurity and diagnosed autism spectrum disorder, although in this case the moderately food insecure group was the only one that remained statistically significant after covariate adjustment (Table 5).

Sensitivity analysis using two levels of food security, food secure and food insecure, showed associations similar to those between moderate household food insecurity and any of the four diagnosed mental health conditions, with children in food insecure households having almost 50% higher odds of having a mental health condition after adjusting for confounders (Supplementary Table 1).

Discussion

This study examined the association between household food insecurity and diagnosed mental health conditions among children aged 5 to 11 years using a nationally representative sample of children in Canada. We found that children living in food insecure households were more likely to have a diagnosed mental health condition, including anxiety or mood disorders, ASD, and ADHD, and this held true after adjustment for sociodemographic and parent/caregiver characteristics. Household food insecurity was dose-dependently associated with a child's likelihood of having a diagnosed mental health condition, speaking to the importance of examining food insecurity by severity when possible. After adjusting for important confounders including income and parent/caregiver mental health, children in severely food insecure households were 67% more likely to have a diagnosed mental health condition compared to children in food secure households.

Previous studies found increased odds of negative mental health outcomes among children and youth living in households experiencing food insecurity. Anderson et al. identified associations between household food security and health care visits for a mental disorder among Canadian children aged 1-17.[16] This study showed increasing prevalence of mental health service use with increasing household food insecurity severity, similar to our study. Men et al. identified relationships between household food security and mental health among Canadian youth aged 12-24.[32] Similar to our findings among children 5-11 years, they showed a dose-response relationship between severity of household food insecurity and mental health, where the odds of presence of diagnosed mental health conditions increased as the severity of household food insecurity increased among adolescents and adults.[32] Sharifi et al. also used CHSCY to examine the relationship between food insecurity and mental health among 1-17 year olds, with similar findings to our study. Our findings expand on the results of Sharifi et al. by using household food insecurity as the exposure, which is a more sensitive measure of a child's experience of food insecurity, by testing the dose-relationship using four levels of food security, and by disaggregating developmental disorders autism spectrum disorder and ADHD.[17]

Household food insecurity can impact a child's mental health through a number of mechanisms.[14] Children from severely food insecure households face reduced quality, quantity, and frequency of meals which may directly impact behavioural difficulties and mental health conditions.[33] An indirect pathway

may be through parental well-being where parents and caregivers experiencing food insecurity may reduce sensitive and responsive parenting from the chronic financial and emotional stress of acquiring food, which can negatively impact the child's overall mental health.[33] This suggests that even if children are not themselves experiencing disrupted eating or hunger, the uncertainty around food affordability and food availability in the family is enough to precipitate mental health conditions.

Our findings also suggest that there is an association with specific mental health conditions, which is aligned with previous research. One US study of children 6 to 12 years showed that food insecurity, dichotomized into two levels, was significantly associated with ADHD.[18] There may also be temporal differences in exposure to food insecurity and the likelihood of developing a mood/anxiety disorder compared to a neurodevelopmental disorder. Macronutrient deficiencies affecting neurotransmitters and neuropsychiatric regulation in the early years may have effects on brain development and subsequent mental health problems.[34] Additionally, psychosocial and environmental effects including parental stress may contribute to the association between food insecurity and child mental health.[34]

One major strength of this study was examining the dose-response relationship of household food insecurity with parent/caregiver-reported diagnosed mental health conditions. Additionally, this is one of the few studies in the literature that analyzes mental health specifically among young children between 5 to 11 years in Canada. The survey used for these analyses, CHSCY, is sampled and weighted to be representative of the child population in Canada. Additionally, food insecurity was captured using the HFSSM, which is well-validated as the primary measurement tool of household food insecurity in Canada. Given the breadth of data collected in the CHSCY, we were also able to control for multiple sociodemographic, family, and economic factors in our analysis, including parent/caregiver mental health, which is an important confounder of the relationship between food security and child mental health.

Certain limitations should be considered when interpreting the results. The study used a cross-sectional design and is therefore unable to determine causality or to detangle the potential bidirectional relationship between food insecurity and child mental health. For instance, poor child mental health may worsen a family's food insecurity by depleting scarce financial and time resources. Additionally, while parents/guardians are better positioned than younger children to provide accurate reporting of child health and household measures, the reliance on parental reports of both household food insecurity and health professional-diagnosed mental health conditions introduces a risk of information biases such as recall and social desirability biases. Further, parental reports have been shown to underestimate children's experience of food insecurity, compared to child reports.[35] To whatever degree this bias was present in our study, it would underestimate food insecurity and likely bias our results towards the null. It is also important to note some limitations of the CHSCY survey. Although the CHSCY data provides nationally representative data, the 2019 response rate to this survey cycle was only 57.8% for children 5 to 11 years and 51.8% overall.[22] This may introduce some selection bias in the population surveyed, although the impact on our findings, if any, is unclear given the correcting use of bootstrap weights and replicates, and existing evidence that response rates on health surveys is not related to nonresponse bias or data representativeness.[36]

Conclusion

This study found that Canadian children aged 5-11 who live in food insecure households are more likely to have been diagnosed with a mental health condition than children in food secure households. Compounded by the increases in child mental health conditions and rising food insecurity rates, both food insecurity and mental health are public health priorities. This study supports the need to implement policies that are focused on creating sustainable systems to alleviate the burden of food insecurity on mental health.

Tables and Figures

Table 1: Characteristics of study population of children age 5-11, by food security status; Canada, 2019

Characteristics	Total	Food secure	Marginally food insecure	Moderately food insecure	Severely food insecure	P-value for differences across groups
Age (Mean years)	8.0	8.0	7.9	8.0	8.2	0.0883
Sex						
Female	48.7	48.6	53.4	47.0	49.5	0.2253
Male	51.3	51.4	46.6	53.0	50.5	0.2253
Household income adjusted for household size (Mean dollars)	52,786	57,781	31,365	28,355	23,969	<.0001
Highest parental education						
High school or less	13.6	10.7	22.8	28.6	33.1	<.0001
College/Trades	38.3	36.6	42.8	48.0	49.5	<.0001
Bachelor's or more	48.2	52.8	34.3	23.4	17.4	<.0001
Race and ethnic origin						
Black	5.6	4.7	8.4	10.9	8.3	<.0001
East Asian	4.7	5.2	3.1	2.9	0.6	<.0001
Indigenous	5.1	3.9	10.5	9.3	15.8	<.0001
Latin American	1.1	1.0	2.6	2.1	0.8	<.0001
Other/Multiple	2.1	1.9	4.2	3.3	1.8	<.0001
South Asian	7.1	7.6	6.4	4.8	1.5	<.0001
Southeast Asian/Filipino	4.1	3.8	7.9	6.4	2.0	<.0001
West Asian/Arab	3.2	3.2	3.8	2.8	4.0	<.0001
White/non-racialized	66.8	68.7	53.2	57.4	65.2	<.0001
Child immigration status						
Immigrant/non-perm resident	9.0	8.8	15.0	8.0	4.9	<.0001
Not immigrant/non-perm resident	91.0	91.2	85.0	92.0	95.1	<.0001
Experience parental separation						
Experienced separation/divorce	18.8	15.9	25.6	32.1	46.2	<.0001
Never experienced separation/divorce	81.2	84.1	74.4	67.9	53.8	<.0001
PMK mental health						
Excellent/very good	71.6	74.6	66.7	56.9	40.7	<.0001
Good	22.8	21.2	26.3	32.9	33.1	<.0001
Fair/poor	5.6	4.2	7.0	10.2	26.3	<.0001

Table 2: Unadjusted and adjusted logistic regression models of the association between household food insecurity status and any diagnosed mental health condition

Variable	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Household Food Security		
Food Secure	REF	REF
Marginally Food Insecure	1.49 (1.08, 2.06)	1.39 (0.99, 1.97)
Moderately Food Insecure	1.99 (1.58, 2.52)	1.46 (1.13, 1.89)
Severely Food Insecure	3.15 (2.32, 4.27)	1.67 (1.18, 2.35)
Age (years)	1.24 (1.20, 1.29)	1.25 (1.21, 1.30)
Sex		
Female	REF	REF
Male	2.44 (2.08, 2.87)	2.70 (2.29, 3.19)
Household Income (adjusted for household size, per $5000)	0.96 (0.94, 0.98)	0.99 (0.97, 1.01)
Highest Level Parent Education		
High school or less	REF	REF
College/Trades	0.80 (0.65, 0.98)	0.97 (0.78, 1.19)
University or more	0.49 (0.40, 0.60)	0.80 (0.63, 1.01)
Parent's Mental Health Status		
Excellent/Very good	REF	REF
Good	2.33 (1.96, 2.77)	1.95 (1.63, 2.34)
Fair/Poor	4.34 (3.45, 5.46)	3.60 (2.80, 4.63)
Race and ethnic origin		
White/non-racialized	REF	REF
Black	0.79 (0.57, 1.09)	0.83 (0.58, 1.18)
East Asian	0.58 (0.39, 0.86)	0.78 (0.51, 1.18)
Indigenous	1.58 (1.20, 2.10)	1.11 (0.83, 1.48)
Latin American	0.56 (0.25, 1.24)	0.67 (0.30, 1.51)
Other/Multiple	0.74 (0.42, 1.28)	0.67 (0.38, 1.20)
South Asian	0.29 (0.19, 0.43)	0.42 (0.28, 0.65)
Southeast Asian/Filipino	0.53 (0.33, 0.85)	0.68 (0.41, 1.14)
West Asian/Arab	0.35 (0.17, 0.71)	0.46 (0.21, 1.02)
Immigration Status		
Non-immigrant	REF	REF
Immigrant/non-permanent resident	0.35 (0.24, 0.52)	0.47 (0.31, 0.72)
Divorce/Separation		
No	REF	REF
Yes	2.26 (1.90, 2.68)	1.47 (1.22, 1.77)

Table 3: Unadjusted and adjusted logistic regression models of the association between household food insecurity status and a diagnosed mood or anxiety disorder

Variable	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Household Food Security		
Food Secure	REF	REF
Marginally Food Insecure	2.27 (1.40, 3.67)	2.18 (1.33, 3.60)
Moderately Food Insecure	2.29 (1.56, 3.35)	1.73 (1.15, 2.59)
Severely Food Insecure	2.92 (1.84, 4.63)	1.48 (0.90, 2.43)
Age (years)	1.30 (1.21, 1.39)	1.30 (1.21, 1.39)
Sex		
Female	REF	REF
Male	1.52 (1.17, 1.97)	1.60 (1.22, 2.09)
Household Income (adjusted for household size, per $5000)	0.97 (0.94, 1.00)	1.00 (0.97, 1.03)
Highest Level Parent Education		
High school or less	REF	REF
College/Trades	1.09 (0.76, 1.57)	1.39 (0.93, 2.06)
University or more	0.64 (0.44, 0.93)	1.14 (0.75, 1.75)
Parent's Mental Health Status		
Excellent/Very good	REF	REF
Good	3.45 (2.58, 4.61)	2.86 (2.12, 3.87)
Fair/Poor	6.03 (4.25, 8.56)	4.85 (3.37, 7.00)
Race and ethnic origin		
White/non-racialized	REF	REF
Black	0.52 (0.25, 1.06)	0.55 (0.26, 1.15)
East Asian	0.58 (0.30, 1.14)	0.78 (0.39, 1.56)
Indigenous	1.67 (1.06, 2.64)	1.17 (0.74, 1.86)
Latin American	0.66 (0.07, 5.88)	0.74 (0.08, 6.52)
Other/Multiple	1.03 (0.34, 3.10)	0.96 (0.33, 2.81)
South Asian	0.26 (0.09, 0.72)	0.38 (0.13, 1.09)
Southeast Asian/Filipino	0.28 (0.11, 0.71)	0.36 (0.14, 0.91)
West Asian/Arab	0.20 (0.05, 0.75)	0.28 (0.07, 1.04)
Immigration Status		
Non-immigrant	REF	REF
Immigrant/non-permanent resident	0.39 (0.20, 0.75)	0.64 (0.32, 1.27)
Divorce/Separation		
No	REF	REF
Yes	2.13 (1.62, 2.80)	1.27 (0.93, 1.72)

Table 4: Unadjusted and adjusted logistic regression models of the association between household food insecurity status and diagnosed attention deficit hyperactivity disorder

Variable	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Household Food Security		
Food Secure	REF	REF
Marginally Food Insecure	1.37 (0.89, 2.11)	1.23 (0.79, 1.93)
Moderately Food Insecure	1.86 (1.39, 2.51)	1.30 (0.95, 1.78)
Severely Food Insecure	3.35 (2.38, 4.73)	1.64 (1.12, 2.39)
Age (years)	1.30 (1.24, 1.35)	1.30 (1.25, 1.37)
Sex		
Female	REF	REF
Male	2.67 (2.18, 3.29)	2.98 (2.41, 3.68)
Household Income (adjusted for household size, per $5000)	0.94 (0.92, 0.97)	0.97 (0.95, 1.00)
Highest Level Parent Education		
High school or less	REF	REF
College/Trades	0.70 (0.55, 0.88)	0.84 (0.66, 1.08)
University or more	0.40 (0.31, 0.51)	0.67 (0.51, 0.90)
Parent's Mental Health Status		
Excellent/Very good	REF	REF
Good	2.16 (1.76, 2.66)	1.71 (1.38, 2.12)
Fair/Poor	3.70 (2.80, 4.91)	2.85 (2.09, 3.88)
Race and ethnic origin		
White/non-racialized	REF	REF
Black	0.67 (0.43, 1.03)	0.66 (0.42, 1.03)
East Asian	0.44 (0.25, 0.78)	0.60 (0.33, 1.09)
Indigenous	1.64 (1.18, 2.27)	1.10 (0.79, 1.56)
Latin American	0.34 (0.11, 1.01)	0.41 (0.14, 1.23)
Other/Multiple	0.46 (0.20, 1.04)	0.41 (0.18, 0.94)
South Asian	0.15 (0.09, 0.27)	0.22 (0.12, 0.39)
Southeast Asian/Filipino	0.34 (0.16, 0.70)	0.43 (0.20, 0.93)
West Asian/Arab	0.42 (0.18, 0.96)	0.53 (0.21, 1.33)
Immigration Status		
Non-immigrant	REF	REF
Immigrant/non-permanent resident	0.34 (0.20, 0.57)	0.51 (0.29, 0.89)
Divorce/Separation		
No	REF	REF
Yes	2.62 (2.15, 3.19)	1.62 (1.31, 2.00)

Table 5: Unadjusted and adjusted logistic regression models of the association between household food insecurity status and diagnosed autism spectrum disorder

Variable	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Household Food Security		
Food Secure	REF	REF
Marginally Food Insecure	1.73 (1.04, 2.87)	1.53 (0.90, 2.59)
Moderately Food Insecure	2.37 (1.59, 3.55)	1.74 (1.14, 2.64)
Severely Food Insecure	2.80 (1.72, 4.57)	1.70 (0.98, 2.94)
Age (years)	0.97 (0.91, 1.04)	0.97 (0.91, 1.04)
Sex		
Female	REF	REF
Male	4.07 (2.80, 5.90)	4.13 (2.85, 6.01)
Household Income (adjusted for household size, per $5000)	0.95 (0.90, 1.00)	0.98 (0.93, 1.03)
Highest Level Parent Education		
High school or less	REF	REF
College/Trades	0.85 (0.57, 1.27)	1.01 (0.67, 1.53)
University or more	0.61 (0.40, 0.92)	0.90 (0.57, 1.41)
Parent's Mental Health Status		
Excellent/Very good	REF	REF
Good	1.87 (1.34, 2.63)	1.69 (1.21, 2.38)
Fair/Poor	4.35 (2.97, 6.36)	3.77 (2.51, 5.64)
Race and ethnic origin		
White/non-racialized	REF	REF
Black	1.27 (0.75, 2.16)	1.29 (0.71, 2.35)
East Asian	1.04 (0.58, 1.87)	1.28 (0.69, 2.35)
Indigenous	1.29 (0.71, 2.34)	0.96 (0.53, 1.73)
Latin American	0.53 (0.01, 31.5)	0.59 (0.01, 35.1)
Other/Multiple	2.06 (0.95, 4.49)	1.74 (0.77, 3.90)
South Asian	0.67 (0.38, 1.18)	0.92 (0.49, 1.72)
Southeast Asian/Filipino	1.43 (0.70, 2.94)	1.59 (0.73, 3.46)
West Asian/Arab	0.31 (0.03, 2.92)	0.40 (0.04, 3.76)
Immigration Status		
Non-immigrant	REF	REF
Immigrant/non-permanent resident	0.50 (0.19, 1.33)	0.57 (0.19, 1.65)
Divorce/Separation		
No	REF	REF
Yes	1.34 (0.97, 1.85)	0.99 (0.69, 1.41)

Footnotes

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oversight. JT, SO, and SC contributed to developing and refining the methods, and interpreting the results. JT, SO, SN, DH, and SC reviewed the manuscript for intellectual content and approved the final version for publication.

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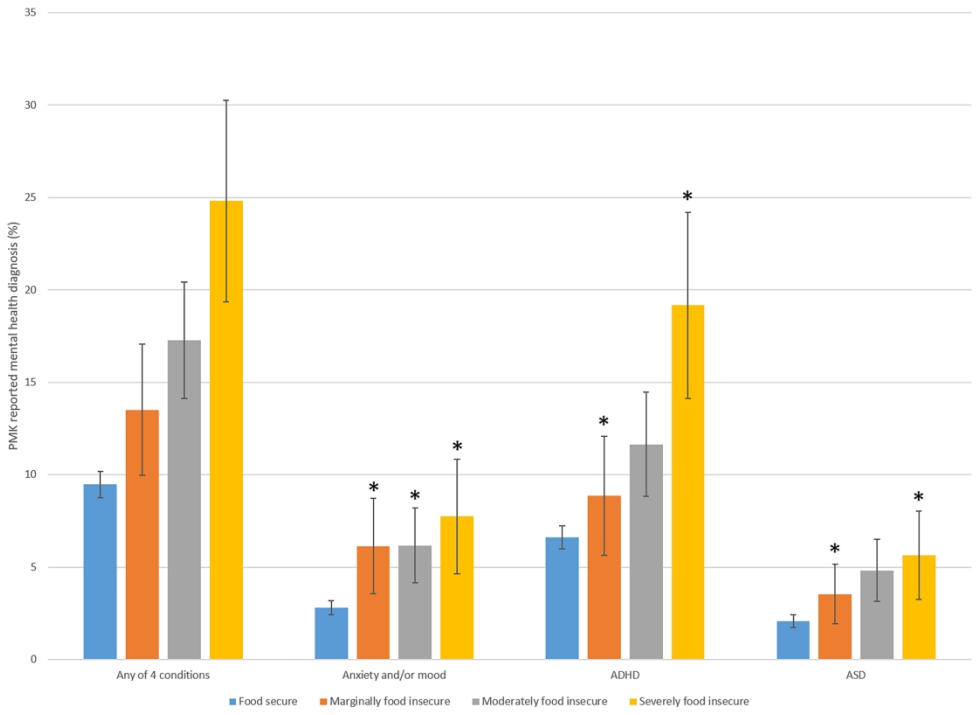
Figure legend

Title: Figure 1 - Prevalence of diagnosed mental health conditions in children 5-11, by food security status; Canada, 2019

Footnotes: PMK = Person Most Knowledgeable, ASD = Autism Spectrum Disorder, ADHD = Attention Deficit Hyperactivity Disorder
*Interpret estimate with caution due to a Coefficient of Variation greater than 15%



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Supplementary Table 1: Unadjusted and adjusted logistic regression models of the association between household food insecurity and any diagnosed mental health condition

Variable	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Household Food Security		
Food Secure	REF	REF
Food Insecure (marginal, moderate, or severe)	2.05 (1.72, 2.44)	1.49 (1.22, 1.82)
Age (years)	1.24 (1.20, 1.29)	1.25 (1.21, 1.30)
Sex		
Female	REF	REF
Male	2.44 (2.08, 2.87)	2.70 (2.29, 3.19)
Household Income (adjusted for household size, per $5000)	0.96 (0.94, 0.98)	0.99 (0.97, 1.01)
Highest Level Parent Education		
High school or less	REF	REF
College/Trades	0.80 (0.65, 0.98)	0.96 (0.78, 1.19)
University or more	0.49 (0.40, 0.60)	0.79 (0.63, 1.01)
Parent's Mental Health Status		
Excellent/Very good	REF	REF
Good	2.33 (1.96, 2.77)	1.95 (1.63, 2.34)
Fair/Poor	4.34 (3.45, 5.46)	3.66 (2.84, 4.70)
Race and ethnic origin		
White/non-racialized	REF	REF
Black	0.79 (0.57, 1.09)	0.83 (0.58, 1.18)
East Asian	0.58 (0.39, 0.86)	0.78 (0.51, 1.18)
Indigenous	1.58 (1.20, 2.10)	1.11 (0.82, 1.48)
Latin American	0.56 (0.25, 1.24)	0.66 (0.29, 1.49)
Other/Multiple	0.74 (0.42, 1.28)	0.67 (0.37, 1.19)
South Asian	0.29 (0.19, 0.43)	0.42 (0.28, 0.64)
Southeast Asian/Filipino	0.53 (0.33, 0.85)	0.68 (0.41, 1.13)
West Asian/Arab	0.35 (0.17, 0.71)	0.47 (0.21, 1.02)
Immigration Status		
Non-immigrant	REF	REF
Immigrant/non-permanent resident	0.35 (0.24, 0.52)	0.47 (0.31, 0.72)
Divorce/Separation		
No	REF	REF
Yes	2.26 (1.90, 2.68)	1.47 (1.22, 1.78)

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4,5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4,5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	4
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	5
		(*e*) Describe any sensitivity analyses	5
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	4
		(b) Give reasons for non-participation at each stage	4
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5,9
		(b) Indicate number of participants with missing data for each variable of interest	N/A
Outcome data	15*	Report numbers of outcome events or summary measures	10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11

		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	6
Discussion			
Key results	18	Summarise key results with reference to study objectives	6
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	7
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	6-8
Generalisability	21	Discuss the generalisability (external validity) of the study results	7,8
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	1

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.