Synergism of female gender and food insecurity in relation to mental health struggles in Canadian adults, data from a cross-sectional survey

Journal:	*CMAJ Open*
Manuscript ID	CMAJOpen-2020-0112
Manuscript Type:	Cross-sectional
Date Submitted by the Author:	16-May-2020
Complete List of Authors:	Pound, Catherine; CHEO, Pediatrics; University of Ottawa Faculty of Medicine, Pediatrics and School of Epidemiology and Public Health Chen, Yue; University of Ottawa Faculty of Medicine, Department of Epidemiology and Community Medicine
Keywords:	Epidemiology, Public health, Mental health
More Detailed Keywords:	food insecurity
Abstract:	Background: Food insecure women are at higher risk of mental health disorders. This study examined the joint effect of female gender and food insecurity on mental health struggles in Canadian adults. Methods: The analysis was based on data from 61,146 adults who participated in the Canadian Community Health Survey 2015-2016. Past year food security levels (secure, moderately, and severely insecure) were determined based on 18 questions. Mental health struggles were defined as poor or fair self-reported mental health. Log-binomial regression was used to explore associations of gender and food insecurity with mental health struggles. Additive interaction between female gender and food insecurity was measured using relative excess risk due to interaction (RERI). Results: Mental health struggles were reported in 6.1% of participants. Increased risk of mental health struggles was associated with female gender (prevalence ratio (PR) 1.22 (95% confidence interval (CI) 1.12, 1.31)), moderate (2.50 (2.21, 2.82)), and severe (4.03 (3.59, 4.52)) food insecurity. Significant additive interaction between female gender and severe food insecurity was found in the 40-64-year age group (RERI 1.38, 95% CI 0.29, 2.47) and the PR for mental health struggles for severely food insecure women was 5.55 (95% CI 4.48, 6.89) compared with food secure men of the same age group. Interpretation: Mental health struggles are common in the food insecure population, and there exist a synergism between female gender and severe food insecurity in middle age individuals. This suggests the need to develop targeted mental health support strategies for food insecure individuals, specifically middle-aged women.

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	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1, 2
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	2
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	2
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	2,3
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	2,3
Bias	9	Describe any efforts to address potential sources of bias	3
Study size	10	Explain how the study size was arrived at	3
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	3
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	3
		(*b*) Describe any methods used to examine subgroups and interactions	3
		(*c*) Explain how missing data were addressed	3
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	3
		(*e*) Describe any sensitivity analyses	3
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	--
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	4
		(b) Indicate number of participants with missing data for each variable of interest	4
Outcome data	15*	Report numbers of outcome events or summary measures	4

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	4, table 2
		(*b*) Report category boundaries when continuous variables were categorized	4, tables 1 and 2
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	--
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	4, table 3
Discussion			
Key results	18	Summarise key results with reference to study objectives	4,5
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	5
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	5
Generalisability	21	Discuss the generalisability (external validity) of the study results	5
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	--

*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.

Synergism of female gender and food insecurity in relation to mental health struggles in Canadian adults, data from a cross-sectional survey

Catherine M. Pound[a,b], MD, MSc(C), Yue Chen, MD, PhD[b]

Affiliations: [a]Department of Pediatrics, Children's Hospital of Eastern Ontario, Ottawa, Canada, [b]Faculty of Medicine, School of Epidemiology, Public Health and Preventive Medicine, University of Ottawa

Address correspondence to: Catherine Pound, Division of Pediatrics, Children's Hospital of Eastern Ontario, Ottawa, Canada, 401 Smyth Road, Ottawa, Ontario, K1H8L1, 613-737-7600, ext 2701, cpound@cheo.on.ca

Contributor Statement:
Dr Pound conceptualized and designed the study, carried out the analyses, interpreted the data, drafted the initial manuscript, reviewed, and revised the manuscript.
Dr Chen participate in the design of the study, reviewed the analyses, participated in the interpretation of the data, reviewed and revised the manuscript
All authors approved the final manuscript as submitted and agrees to be accountable for all aspects of the work.

Funding source: There is no specific funding support associated with this study.

Abstract

Background: Food insecure women are at higher risk of mental health disorders. This study examined the joint effect of female gender and food insecurity on mental health struggles in Canadian adults.

Methods: The analysis was based on data from 61,146 adults who participated in the Canadian Community Health Survey 2015-2016. Past year food security levels (secure, moderately, and severely insecure) were determined based on 18 questions. Mental health struggles were defined as poor or fair self-reported mental health. Log-binomial regression was used to explore associations of gender and food insecurity with mental health struggles. Additive interaction between female gender and food insecurity was measured using relative excess risk due to interaction (RERI).

Results: Mental health struggles were reported in 6.1% of participants. Increased risk of mental health struggles was associated with female gender (prevalence ratio (PR) 1.22 (95% confidence interval (CI) 1.12, 1.31)), moderate (2.50 (2.21, 2.82)), and severe (4.03 (3.59, 4.52)) food insecurity. Significant additive interaction between female gender and severe food insecurity was found in the 40-64-year age group (RERI 1.38, 95% CI 0.29, 2.47) and the PR for mental health struggles for severely food insecure women was 5.55 (95% CI 4.48, 6.89) compared with food secure men of the same age group.

Interpretation: Mental health struggles are common in the food insecure population, and there exist a synergism between female gender and severe food insecurity in middle age individuals. This suggests the need to develop targeted mental health support strategies for food insecure individuals, specifically middle-aged women.

Abstract word count: 250 words
Text word count: 1931 words

Keywords: food insecurity, mental health, population, survey, women

INTRODUCTION

Food insecurity is defined as the "inability to acquire or consume an adequate diet quality or sufficient quantity of food in socially acceptable ways, or the uncertainty that one will be able to do so" (1). In Canada, approximately 8 to 12% of households are reported to experience food insecurity (2,3), secondary to significant financial constraints. Food insecurity is linked to poverty, single-parent household status, reliance on social assistance (4), and low educational attainment (5). Food insecurity may increase the risks of multiple adverse health consequences, including malnutrition secondary to nutrient inadequacies (6), diabetes (7), cardiovascular disease (8), and obesity (9). In addition, significant associations have been reported between food insecurity and mental health disorders, specifically mood and/or anxiety disorders (4,10). One Canadian study reported a prevalence of mental illness of 35% in individuals with food insufficiency (11). In contrast, compared with about 10% in the general Canadian population (12). Women, as compared to men, have been described to be at increased risk of poor mental health in relation to food insecurity (4,13), irrespective of educational attainment (14), and are more likely to suffer from food insecurity (15). In addition, single mothers are disproportionately affected by food insecurity (16), with more than

one third of female lone-parent families suffering from food insecurity in Canada in 2014 (3), raising concerns for potential negative impacts on children's physical and mental wellbeing. Our study aimed to determine the joint effect of female gender and food insecurity on perceived self-reported mental health difficulties in Canadian adults.

METHODS

Data Source

The current study was based on data from the Canadian Community Health Survey (CCHS) 2015-2016 (19). The Canadian Community Health Survey (CCHS) is a cross-sectional survey that gathers information related to the health status and determinants of health of the Canadian population (20). It collects data from individuals 12 years or over living in the ten provinces and three territories. People living on reserves and other Aboriginal settlements, full-time members of the Canadian Forces, institutionalized individuals, children aged 12 to 17 living in foster care, and people living in the Nunavik Region and the Terres-Cries-de-la-Baie-James are excluded from the sampling frame (<3% of the target Canadian population) (21). The overall response rate was 59.5% (20).

Study Population

All participating adults (18 years or over) with data on food security status and perceived mental health difficulties were included. Perceived mental health was selected as a health outcome, as opposed to diagnosed mental health illness, so as to include individuals who have not received a diagnosis from a health care provider, but may still be suffering from mental health difficulties. Around 15% of Canadians do not have a family physician (22), making access to care difficult for a subset of the population. Estimates based on diagnosed mental health disorders may therefore underestimate the association between food insecurity and mental health illness.

Measurement of mental health struggles

Five levels of self-reported perceived mental health states (poor, fair, good, very good, and excellent) are collected by the CCHS (19). Individuals with mental health struggles were those who reported poor or fair mental health.

Combined exposure of food insecurity and gender

The household food security variable in the CCHS was based on a set of 18 questions that described the food security situation of each household in the previous 12 months (19): food secure, moderately insecure, and severely insecure. To determine the effect of the joint exposure of gender and food security, participants were grouped into six categories ("male and food secure", "male and moderately food insecure", "male and severely food insecure", "female and food secure", "female and moderately food insecure", "female and severely food insecure"), and we used the "male and food secure" group as the reference.

Covariates

Potential confounding factors were identified a priori from a review of the literature. They included age (18-39, 40-64, 65+ years), marital status (married or common-law, widowed or

divorced or separated or single), number of household members (1-2, 3-4, 5+), educational level (<secondary school, secondary school completed, >secondary school) and smoking status (current smoker (daily or occasionally), former smoker, non-smoker).

Statistical analyses

Descriptive statistics were used to describe the distributions the outcome, exposure of interest and covariables. Chi-square test was used for group comparisons. Log binomial regression was used to determine the prevalence of perceived mental health difficulties associated with gender and food insecurity, taking potential confounding factors into consideration. Crude and adjusted prevalence ratios (PRs) and their 95% confidence intervals (CIs) were calculated. To measure the additive interaction between female gender and food insecurity in association with perceived mental health difficulties, we used relative excess risk due to interaction (RERI), attributable portion due to interaction (AP) and Synergy (S)-index. Age was found to be an effect modifier at a level of $P<0.05$, and therefore, we provided age-specific additive interaction measures. To account for the complex survey design (stratified and cluster sampling with unequal selection probabilities), we used adjusted weights that were calculated based on sampling weights and average design effect, for all the point and variance estimations. All statistical analyses were performed using SAS 9.4 software.

Ethics Approval

Ethics approval was not required for this study.

RESULTS

A total of 61,146 individuals were included in the analysis. Initially, 61,482 individuals had data available for the exposure (gender and food security status) and the outcome (perceived mental health difficulties) of interest. Listwise deletion was performed for covariates with missing values of less than 1% (151 for smoking status, 147 for marital status, and 38 for household size). An "unknown" group was created for education level, since 1.3% of individuals had missing data for this particular variable.

Table 1 shows the prevalence of perceived mental health struggles and the distribution of food security status. Overall, 6.1% of the participants reported perceived mental health struggles, and 7.6% reported some degree of food insecurity. The prevalence of perceived mental health struggles increased with the level of food insecurity, which was more so for females (food secure: 5.3%; moderately food insecure: 15.6%; severely food insecure 32.5%) than males (4.5%; 14.4%; 25.2%).

Table 2 summarizes adjusted prevalence ratios for gender and food insecurity in association with self-reported mental health struggles. Log-binomial models were used to adjust for potential confounder such as education, marital status, smoking, and household size, and the estimates for the joint exposure of gender and food insecurity were stratified by age. Overall, the prevalence of perceived mental health struggles was significantly higher in females than males (PR 1.22, 95% CI 1.12, 1.31) and in those with moderate food insecurity (PR 2.50, 95% CI 2.21, 2.82) or severe food insecurity (PR 4.03, 95% CI 3.59, 4.52) compared with those without

food insecurity. The adjusted prevalence ratio for perceived mental health struggles was 5.05 (4.39, 5.82) for women experiencing severe food insecurity compared with men with food security in the young age group, 5.55 (4.48, 6.89) in the middle age group, and 2.97 (1.48, 5.95) in the elderly (Table 2).

Additive interaction measures including relative excess risk due to interaction (RERI), attributable portion due to interaction (AP) and Synergy (S)-index were provided in Table 3. Overall, there was a significant synergism between female gender and severe food insecurity in association with the risk of perceived mental health struggles. When stratified by age, the synergistic effect was only significant for the 40-64-year age group (RERI 1.38, 95% CI 0.29, 2.47; AP 0.28, 95% CI 0.09, 0.47; S 1.54, 95% 1.07, 2.21).

INTERPRETATION

This study showed that the prevalence of perceived mental health struggles was much higher in the moderately and severely food insecure groups (15.1% and 29.3%, respectively) than in the food secure group (4.9%). The dose-response relationship seen in this study between severity of food insecurity and the risk of mental health struggles is consistent with what has previously been reported (10). Our data clearly showed an association between food insecurity and perceived mental health difficulties in all studied age categories. Additionally, for any given level of food insecurity, point estimates of association measures are higher in females than in males, except in the elderly. This protective effect of age in women is interesting and has not previously been described. One plausible hypothesis for this could be that older women typically do not have children living under their roof, and therefore no longer need to worry about providing food for them, relieving some of the stress associated with food insecurity.

There existed additive interaction between female gender and food insecurity, suggesting a synergistic effect on the perceived mental health struggles. This synergism was significantly modified by age. When stratified by age, additive interaction between female gender and severe food insecurity was clearly identified in the middle age group. There was a 138% (95% CI 29-247%) excess risk of perceived mental health struggles due to this interaction for 40 to 64-year old women with severe food insecurity relative to the risk for food secure men of the same age bracket. This finding is consistent with previous reports showing that women are at greater risk of mental health issues in relation to food insecurity (4,13,14). However, this additive interaction was less marked in the younger age group, and absent in the older age group. This age-related difference is a novel finding, and a recent review of 31 studies of food insecurity and mental health in women living in high income countries noted the paucity of research focusing on older women (4). However, our study clearly highlights the association of female gender and food insecurity in relation to mental health struggles in 40 to 64 year-old women, emphasizing the need to develop interventions targeted to that age group. Research focusing on elderly women affected by food insecurity would be helpful to explore potential specific resiliency factors that may confer a protective effect.

Limitations

There are several limitations to this study. Aboriginal individuals living on reserve, known to be at high risk for both food insecurity and mental health difficulties (23), are excluded from the CCHS' sampling frame. Homeless individuals, also at greater risk of food insecurity (24) are excluded. The choice of outcome of interest, self-perceived mental health struggles, as compared to the outcome diagnosed mental health illness, can be considered both a limitation and a strength. While self-reporting of mental health states is not based on any strict criteria, it does allow to include individuals who suffer from mental health difficulties but have not been diagnosed, due to a multitude of reasons, including lack of access to care. Although self-reported mental health states cannot be used to assess the prevalence of specific disorders such as depression and anxiety, it allows for a broader inclusion of people are risk by potentially identifying subclinical issues. Finally, because the CCHS is cross-sectional in nature, temporality of the association cannot be established with certainty.

Conclusion

This study demonstrates the high prevalence of mental health struggles in the food insecure population, and highlights the association between food insecurity and perceived mental health struggles. It also emphasizes the interaction of female gender and food insecurity, especially in the 40-64 year age group. Given the current novel Coronavirus (COVID-19) situation and the very unstable financial climate, the 7.6% prevalence of moderate and severe food insecurity reported in this survey is likely to significantly increase over the next few months, potentially resulting in an even higher burden of mental health issues in this subset of the Canadian population. There is therefore an urgent need to develop strategies to support the mental health of food insecure individuals, specifically targeting middle-aged women, in light of their heightened risk of poor mental health outcomes in relation to food insecurity.

Data-Sharing Statement: The data used in this study is publicly available.

References

1. Davis B, Tatasuk V. Hunger in Canada. Agriculture and Human Values 1994;11(4):50-7.
2. Government of Canada. Health at a Glance--Food insecurity in Canada. 2015. https://www150.statcan.gc.ca/n1/pub/82-624-x/2015001/article/14138-eng.htm (accessed May 12, 2020)
3. Tarasuk, V, Mitchell, A, Dachner, N. (2016). Household food insecurity in Canada, 2014. Toronto: Research to identify policy options to reduce food insecurity (PROOF). https://proof.utoronto.ca/wp-content/uploads/2016/04/Household-Food-Insecurity-in-Canada-2014.pdf (accessed May 12, 2020)
4. Maynard M, Andrade L, Packull-McCormick, Perlman CM, Leos-Toro C, Kirkpatrick SI. Food Insecurity and Mental Health among Females in High-Income Countries. Int J Environ Res Public Health. 2018;15(7):1424.
5. Lund TB, Holm L, Tetens I, Smed S, Nielsen AL. Food insecurity in Denmark-socio-demographic determinants and associations with eating- and health-related variables. Eur J Public Health. 2018;28(2):283-8
6. Kirkpatrick IS, Tarasuk V. Food insecurity is associated with nutrient inadequacies among Canadian adults and adolescents. J Nutr. 2008; 138(3):604-2.
7. Gucciardi E, Vogt JA, DeMelo M, Steward DE. Exploration of the relationship between household food insecurity and diabetes in Canada. Diabetes Care. 2009;32:2218-24.
8. Morales ME, Berkowitz SA. The Relationship Between Food Insecurity, Dietary Patterns and Obesity. Curr Nutr Rep. 2016;5(1):54-60.
9. Dhurandhar EJ. The food-insecurity obesity paradox: A resource scarcity hypothesis. Physiol Behav. 2016;162:88-92.
10. Jessiman-Perreault G, McIntyre L. The household food insecurity gradient and potential reductions in adverse population mental health outcomes in Canadian adults. SSM Popul Health. 2017; 3:464-72.
11. Muldoon KA, Duff PK, Fielden S, Anema A. Food insufficiency is associated with psychiatric morbidity in a nationally representative study of mental illness among food insecure Canadians. Soc Psychiatry Psychiatr Epidemiol. 2013;48(5):795-803.
12. McRae L, O'Donnell S, Loukine L,Rancourt N, Pelletier C Report summary—Mood and Anxiety Disorders in Canada, 2016. Health Promot Chronic Dis Prev Can. 2016;36(12):314-5.
13. Ivers LC, Cullen KA. Food insecurity: Special considerations for women. Am J Clin Nutr. 2011;94(6):1740S-1744S.
14. Koury AJ, Dynia J, Logan JAR, Purtell KM, Joy E, Salsberry P. Food Insecurity and Depression among Economically Disadvantaged Mothers: Does Maternal Efficacy Matter? Appl Psychol Health Well Being. 2020.doi:10.1111/aphw.12191
15. Maheux H., Chui T. Women in Canada: A Gender-Based Statistical Report. Statistics; Ottawa, ON, Canada: 2011. https://www150.statcan.gc.ca/n1/en/catalogue/89-503-X (accessed May 12, 2020)
16. Power M, Uphoff EP, Stewart-Knox B, Small N, Doherty B, Pickett KE. Food insecurity and socio-demographic characteristics in two UK ethnic groups: an analysis of women in the Born in Bradford cohort. J Public Health (Oxf) 2018; 40(1):32-40.
17. Bergman RS, Coughlin L, Wilson T, Malecki K. Cross-sectional associations of food insecurity with smoking cigarettes and heavy alcohol use in a population-based sample of adults. Drug Alcohol Depend. 2019; 205:107646
18. Tabrizi JS, Nikniaz L, Sadeghi-Bazargani, Farahbakhsh, Nikniaz Z. Socio-demographic Determinants of Household Food Insecurity among Iranian: A Population-based Study from Northwest of Iran. Iran J Public Health. 2018; 47(6): 893-900.

19. Canadian Community Health Survey (CCHS) Annual Component, PUMF, 2015-2016. Derived Variable (DV) Specifications.
20. Canadian Community Health Survey (CCHS) Annual Component, User guide. 2016 Microdata file
21. Canadian Community Health Survey (CCHS) Annual Component, Study Documentation, 2015-2016.
22. Statistics Canada. Health Fact Sheets. Primary health care providers, 2017. https://www150.statcan.gc.ca/n1/pub/82-625-x/2019001/article/00001-eng.htm (accessed May 12, 2020)
23. Nelson SE, Wilson K. The mental health of Indigenous peoples in Canada: A critical review of research. Soc Sci Med. 2017; 176:93-112
24. Parpouchi M, Moniruzzaman A, Russolillo A, Somers JM. Food Insecurity among Homeless Adults with Mental Illness. PLoS One. 2016;11(7):e0159334.

Table 1. Distribution (%) of perceived mental health struggles by gender, food security status and covariates*

Characteristics	Total (n=61,446)	With mental health struggles (n=4107) (6.1)	Without mental health struggles (n=57,339) (93.9)	p-value
Food security				<0.0001
Food secure	56,114 (92.4)	2907 (4.9)	53,207 (95.1)	
Moderately food insecure	3189 (4.8)	540 (15.1)	2,649 (84.9)	
Severely food insecure	2143 (2.8)	660 (29.3)	1483 (70.7)	
Sex				0.0068
Male	28,000 (49.4)	1788 (5.4)	26,212 (94.6)	
Female	33,446 (50.6)	2319 (6.7)	31,127 (93.3)	
Food security and sex				<0.0001
Male and food secure	25,894 (46.2)	1326 (4.5)	24,568 (95.5)	
Male and moderately food insecure	1215 (2.0)	201 (14.4)	1014 (85.7)	
Male and severely food insecure	891 (1.2)	261 (25.2)	630 (74.8)	
Female and food secure	30,220 (46.3)	1581 (5.3)	28,639 (94.7)	
Female and moderately food insecure	1974 (2.9)	339 (15.6)	1635 (84.4)	
Female and severely food insecure	1252 (1.5)	399 (32.5)	853 (67.5)	
Age (years)				<0.0001
18-39	18,622 (37.7)	1282 (6.5)	17,340 (93.5)	
40-64	25,765 (43.7)	1949 (6.3)	23,816 (93.7)	
65+	17,059 (18.6)	876 (4.8)	16,183 (95.2)	
Marital status				<0.0001
Married/common-law	34,299 (63.6)	1612 (4.6)	32,680 (95.4)	
Widowed/divorced/ separated/single	27,147 (36.4)	2488 (8.7)	24,659 (91.3)	
Household members				<0.0001
1-2	41,782 (53.4)	2946 (6.5)	38,836 (93.5)	
3-4	15,409 (35.7)	914 (5.7)	14,395 (94.3)	
5+	4255 (10.9)	247 (5.0)	4008 (95.0)	
Education				<0.0001
<secondary	9675 (12.0)	997 (9.9)	8678 (90.5)	
Secondary completed	13,823 (22.7)	932 (6.1)	12,891 (93.9)	
>secondary	37,247 (64.0)	2136 (5.4)	35,111 (94.6)	
Missing	701 (1.3)	42 (5.7)	659 (94.3)	
Smoking				<0.0001
Current	12,169 (18.6)	1411 (10.7)	10,608 (89.3)	
Former	19,697 (28.6)	1186 (5.5)	18,273 (94.5)	
Never	29,580 (52.8)	1511410 (4.7)	28,069 (95.3)	

* All percentages are weighted to the Canadian population

Table 2. Adjusted prevalence ratios (PRs) and 95% confidence intervals (CIs) for association of gender and food security status with perceived mental health struggles.

			PR	95% CI
Individual exposures of gender and food security*				
Gender		**Male**	1	Referent
		Female	1.22	1.12-1.31
Food security		**Food secure**	1	Referent
		Moderately food insecure	2.50	2.21-2.82
		Severely Food insecure	4.03	3.59-4.52
Joint exposure of gender and food security by age**				
Overall	**Male**	**Food secure**	1	Referent
		Moderately food insecure	2.65	2.19-3.21
		Severely food insecure	3.78	3.17-4.51
	Female	**Food secure**	1.20	1.10-1.32
		Moderately food insecure	2.91	2.49-3.41
		Severely food insecure	5.05	4.39-5.82
18-39 years	**Male**	**Food secure**	1	Referent
		Moderately food insecure	2.11	1.52-2.92
		Severely food insecure	4.15	3.19-5.40
	Female	**Food secure**	1.43	1.22-1.66
		Moderately food insecure	3.48	2.79-4.34
		Severely food insecure	5.55	4.48-6.89
40 to 64 years	**Male**	**Food secure**	1	Referent
		Moderately food insecure	3.13	2.43-4.03
		Severely food insecure	3.42	2.63-4.44
	Female	**Food secure**	1.14	0.99-1.32
		Moderately food insecure	2.56	1.99-3.28
		Severely food insecure	4.94	4.06-6.02
65 years	**Male**	**Food secure**	1	Referent
		Moderately food insecure	3.79	2.03-7.06
		Severely food insecure	5.80	3.02-11.11
	Female	**Food secure**	0.94	0.74-1.20
		Moderately food insecure	2.13	1.19-3.80
		Severely food insecure	2.97	1.48-5.95

*: Variables included in the model were gender, food security status, age, education, marital status, smoking and household size

**: Variables included in the models were combination of gender and food security status, age (overall model only), education, marital status, smoking and household size

Table 3. Measures of additive interaction for sex and food security status in association with perceived mental health struggles, overall and stratified by age group

Age (years)		Additive interaction measures		
		RERI[1] (95% CI[2])	AP[3] (95% CI)	S[4]-index (95% CI)
Overall	**Severe food insecurity female vs male**	***1.07* (0.24-1.89)***	***0.21* (0.06-0.36)***	***1.36* (1.06-1.74)***
	Moderate food insecurity female vs male	0.05 (-0.57-0.68)	0.02 (-0.20-0.23)	1.03 (0.74-1.44)
18-39	**Severe food insecurity female vs male**	0.97 (-0.38-2.33)	0.18 (-0.05-0.40)	1.27 (0.90-1.79)
	Moderate food insecurity female vs male	***0.95* (0.02-1.87)***	***0.27* (0.04-0.51)***	1.62 (0.97-2.70)
40-64	**Severe food insecurity female vs male**	***1.38* (0.29-2.47)***	***0.28* (0.09-0.47)***	***1.54* (1.07-2.21)***
	Moderate food insecurity female vs male	-0.72 (-1.65-0.22)	-0.28 (-0.68-0.12)	0.68 (0.42-1.11)
65+	**Severe food insecurity female vs male**	-2.7 (-6.93-1.40)	-0.93 (-2.70-0.84)	0.42 (0.12-1.47)
	Moderate food insecurity female vs male	- 1.60(-4.18-0.98)	-0.75 (-2.18-0.68)	0.41 (0.11-1.55)

*: value statistically significant

[1]: RERI : relative excess risk due to interaction

[2] CI: confidence interval

[3]: AP: attributable portion due to interaction

[4] : S-index : synergy index

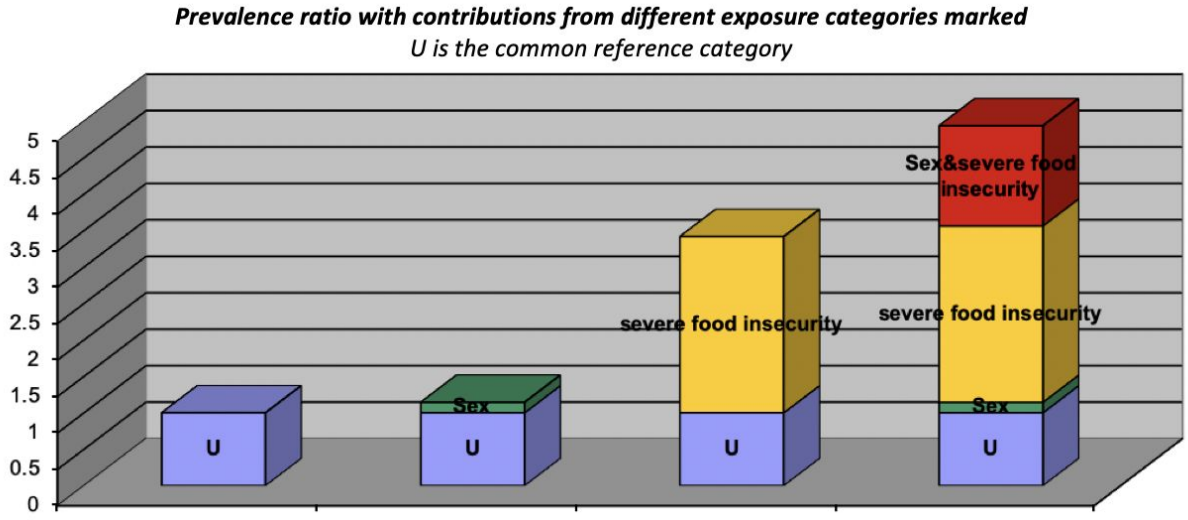

Figure 1: Synergism between female gender and severe food insecurity in association with perceived mental health struggles in the 40-64 year age group