

Accepted Manuscript

Title: The association of food security with psychological distress in New Zealand and any gender differences

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PII: S0277-9536(11)00153-5

DOI: [10.1016/j.socscimed.2011.03.009](https://doi.org/10.1016/j.socscimed.2011.03.009)

Reference: SSM 7800

To appear in: *Social Science & Medicine*

Please cite this article as: Carter, K.N., Kruse, K., Blakely, T., Collings, S. The association of food security with psychological distress in New Zealand and any gender differences, *Social Science & Medicine* (2011), doi: 10.1016/j.socscimed.2011.03.009

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The association of food security with psychological distress in New Zealand and any gender differences.

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Abstract: 298

Total Word Count: 8510

References: 77

Keywords: New Zealand; Psychological Distress; Food Security; Socioeconomic Status; gender

Acknowledgements

SoFIE-Health is primarily funded by the Health Research Council of New Zealand as part of the Health Inequalities Research Programme. We would like to acknowledge Dr Fiona Imlach Gunasekara for reviewing the manuscript.

Statistics New Zealand Security Statement

Access to the data used in this study was provided by Statistics New Zealand in a secure environment designed to give effect to the confidentiality provisions of the Statistics Act, 1975. The results in this study and any errors contained therein are those of the author, not Statistics New Zealand.

Abstract

Food security (access to safe, nutritious, affordable food) is intrinsically linked to feelings of stress or distress and it is strongly associated with socioeconomic factors. However, the impact of food insecurity on mental health, independent of confounding socioeconomic factors, is not clear. We investigated the association of food insecurity with psychological distress in New Zealand, controlling for socioeconomic factors. Secondly, we examined the association in males and females. We used data from the Survey of Families, Income and Employment (SoFIE) (N=18,955). Respondents were classified as food insecure if, in the last 12 months, they: used special food grants/banks, had to buy cheaper food to pay for other things, or went without fresh fruit and vegetables often. Psychological distress was measured using the Kessler-10 scale dichotomised at low (10-15) and moderate to high (16+). Logistic regression analyses were used to investigate the association of food insecurity with psychological distress using a staged modelling approach. Interaction models included an interaction between food security and gender, as well as interactions between gender and all other covariates (significant at p-value < 0.1). Models were repeated, stratified by gender.

A strong relationship between food insecurity and psychological distress was found (crude odds ratio OR 3.4). Whilst substantially reduced, the association remained after adjusting for confounding demographic and socioeconomic variables (adjusted OR 1.8). In stratified models, food insecure females had slightly higher odds for psychological distress (fully adjusted OR 2.0) than males (fully adjusted OR 1.5). As such, an independent association of food insecurity with psychological distress was found in both males and females – slightly more so in females. However, we cannot rule out residual confounding as an explanation for the independent association and any apparent gender interaction.

Introduction

Basic necessities such as adequate food, clothing and housing are fundamental to a person's wellbeing (Ministry of Social Development, 2008). Food security is defined as the assured ability to acquire nutritionally adequate and safe food that meets cultural needs, and has been acquired in a socially acceptable way (Bowers et al., 2009; Carter et al., 2010b; Parnell et al., 2001; Rush et al., 2009). Conversely, food insecurity exists largely as a consequence of limited resources, a problem affecting many households worldwide and in New Zealand (NZ) (Alaimo, 2005; Carter et al., 2010b; Hamelin et al., 2002; Parnell et al., 2001; Russell et al., 1999; Stuff et al., 2004; Tarasuk, 2005; Vozoris et al., 2003). Food security not only influences nutrition and physical health, but it may also affect a person's mental health. Food insecure individuals may experience psychological distress as a result of lack of access to nutritious, affordable, culturally appropriate food and the inability to feed themselves and their families.

This paper aims to determine the association between food security and psychological distress and whether the association persists after controlling for confounding by demographic and socioeconomic factors. We also examine if this association differs by gender. The introduction to this paper is structured as follows. Firstly we describe food security in NZ and other developed countries. Then we discuss the potential impacts of food security on mental health and how this may be confounded by socioeconomic factors. Finally, we discuss how the association of food security with mental health may differ by gender and how this may be due to different gender mechanisms or to differential error and confounding by gender.

The Determinants of Food Security

Despite relatively high standards of living, food insecurity occurs even in developed countries that have an ample supply of food (Riches, 1999). In NZ, 13% of households reported that they can only sometimes afford to eat properly and 14% reported that food runs out in the household because of money ("sometimes" 12% and "often" 2%) (Russell et al., 1999). Similar rates of food insecurity have been found in the United States and Canada (10%-12%) (Che et

al., 2001; Nord et al., 2009; Whitaker et al., 2006). It has been shown that women tend to report food insecurity more often than men (Alaimo et al., 1998; Hamelin et al., 2002; Kaiser et al., 2007; Nord et al., 2009; Russell et al., 1999; Tarasuk, 2005; Temple, 2008). Ethnicity is also strongly associated with food security. In NZ, more Māori (indigenous population) and Pacific (mostly post World War II migrants from Pacific Islands) households reported that they could only sometimes afford to eat properly, as compared to households of European or other descent (29%, 38%, and 10%, respectively) (Russell et al., 1999). In the U.S., Hispanics and African Americans are more likely to report food insecurity than Caucasians (Alaimo et al., 1998; Kaiser et al., 2007; Laraia et al., 2006).

Although there are a number of different measures of food insecurity used worldwide, each measure similar constructs of lack of food due to economic deprivation (Innes-Hughes et al., 2010; Keenan et al., 2001; Radimer, 2006; Tarasuk, 2005). Hence, food security has been shown to be strongly associated with income and the accessibility of material resources within households. Many studies have shown a strong association between income and food security (Che et al., 2001; Collins, 2009; Hamelin et al., 2002; Kaiser et al., 2007; Laraia et al., 2006; Nord et al., 2009; Temple, 2008). In the U.S., food insufficiency (a more extreme form of food insecurity which relates to hunger) was primarily determined by poverty (Alaimo et al., 1998). In NZ, food insecurity is more prevalent in low income households, among those living in deprived neighbourhoods (Russell et al., 1999), and in households with five or more children (Ministry of Health, 2003). These findings are consistent with those in other developed countries (Alaimo et al., 1998; Nord et al., 2009; Tarasuk, 2005).

Food Security and Mental Health

Food insecurity is associated with many adverse health outcomes. Insufficient food or a lack of nutritious foods can lead to inadequate nutrition, resulting in compromised intakes of energy and nutrients (Kendall et al., 1996; Olson, 2005; Rose et al., 1997; Tarasuk et al., 1999); lower physical performance (Klesges et al., 2001); multiple chronic conditions, and obesity (Che et al., 2001). Subjective well-being and self-rated health are also compromised by food insecurity. Individuals who lack adequate access to food more often report fair or

poor health status, compared to those who are food secure (Stuff et al., 2004; Temple, 2008; Vozoris et al., 2003).

In addition to physical health outcomes, mental health can also be affected by food insecurity. A number of studies report an association of food insecurity with mental disorders such as depression (Casey et al., 2004; Heflin et al., 2005; Klesges et al., 2001; Laraia et al., 2006; Temple, 2008; Vozoris et al., 2003; Whitaker et al., 2006), distress (Vozoris et al., 2003), anxiety (Siefert et al., 2004; Whitaker et al., 2006), and lower scores on Physical and Mental Health (SF-12) scores (Stuff et al., 2004). In NZ, 12% of households said that they were sometimes or often stressed about not having enough money for food (Russell et al., 1999). A longitudinal study of female welfare recipients in the U.S. used fixed effects analysis (controlling for within-individual variation and temporal changes in other factors such as family status and socioeconomic measures) and found that the odds of becoming depressed doubled as a result of becoming food insecure (Heflin et al., 2005; Siefert et al., 2004). The correlation between food security and mental health has also been established in many developing countries (Hadley et al., 2006; Hadley et al., 2008; Maes et al., 2010; Roberts et al., 2009).

We argue that socioeconomic status (SES) may confound the relationship between food insecurity and mental health, as strong socioeconomic disparities have been shown across a number of mental disorders (Dohrenwend et al., 1992; Fryers et al., 2003; Muntaner et al., 2004; Skapinakis et al., 2006). Income has a strong (inverse) dose-response relationship with mental health and psychological well-being (Hauck et al., 2004; Kaplan et al., 2008). Similarly, a decrease in the material standard of living over time is associated with an increase in depressive symptoms as well as caseness of major depression (Lorant et al., 2007). This association holds in NZ, where nearly half of the population experiences a mental disorder at some point in their lives, and the 12-month prevalence of disorders is higher for people with lower income or education levels or living in highly deprived areas (M.A. Oakley Browne et al., 2006).

Taking this information together, SES is an important confounder of the food security mental health relationship. Therefore, we aim to examine the effects of

controlling for various measures of SES on the relationship between food security and mental health. We hypothesize that most of the association will be explained by including different measures of adult SES and deprivation to the model. This investigation is important for policy development around food security and welfare in developed countries. If the relationship is mostly explained by, for example, household income, then policy around raising the levels of resources in low income and beneficiary households and moving households and families out of poverty should be further prioritised, as opposed to any policy development specifically addressing mechanisms in any causal pathway from food insecurity to psychological distress.

Gender Differences in Food Security and Mental Health

Assuming at least some causal relationship between food insecurity and mental health exists, several explanations have been posited as mechanisms for this relationship. Firstly, physical health may mediate the relationship, such that food insecurity could negatively affect physical health, which in turn influences mental health (Collins, 2009; Siefert et al., 2004). Secondly, food insecurity may act as a stressor in women, where individuals may feel that they are not successful if they cannot procure adequate amounts of food (Collins, 2009; Siefert et al., 2004). Related to this mastery, the sense of control over one's life, may mediate the relationship of food security with depression in women only (Siefert et al., 2004). This hypothesis is supported by the evidence that belief in external control (a low level of mastery) is associated with low SES, which is a strong predictor of food insecurity (Leach et al., 2008) and may therefore serve as a link between food security and mental health. It has also been shown that mastery, along with other psychosocial factors, explains much of the gender differences in depression and anxiety (Leach et al., 2008).

Studies of gender differences in health have consistently shown that women experience (or report) higher levels of distress or mental illness than men (Kessler et al., 2003b; Macintyre et al., 1996; Matthews et al., 1999; McDonough et al., 2001). Anxiety and depression are associated with the combination of a working role and parenthood among Dutch women but not men (Plaisier et al., 2008). A multi-national study found that part, but not all, of the gender differences in

depression could be explained by social roles (Maier et al., 1999). The mechanisms for gender differences in the impact of food security on mental health may be related to the different roles of males and females. In NZ (as in most other developed countries) women retain the primary responsibility for household tasks and child caring even if they are in paid employment (Ministry of Social Development, 2009; Statistics New Zealand, 2009). Women have been shown to protect others in the household from experiencing food insecurity, which may explain why some women have compromised levels of energy and nutrient intake (McIntyre et al., 2003; Olson, 2005; Parnell et al., 2001). Also, the responsibility of providing food for a household more often falls on women, which may lead to increased stress among this group (Olson, 2005; Parnell et al., 2001). Sole parents (who are more likely to be food insecure) are also more likely to be women, and sole parenthood is associated with less economic stability, being a beneficiary (on welfare), and high stress (Ministry of Social Development, 2009; Parnell et al., 2001; Saunders, 1998). These findings suggest that, in some respects, women's mental health may be more influenced by income and social roles, compared to men's in similar situations. Such an argument may extend to differential vulnerability to food insecurity by gender. We hypothesise that the association of food insecurity with mental health may be stronger among women.

Alternatively, an apparently stronger food security-mental health association in females may be due to differential amounts of systematic error in the association by gender. We use an epidemiological framework to consider this possibility. Most notably, there may be differential confounding of SES by gender on the food security-mental health relationship. For example, the relationship between income and mental health is stronger in women compared to men in Britain (Hauck et al., 2004), and the ability to meet family financial needs is more strongly associated with self-rated health among women than men in Canada (Muhajarine et al., 2006). Thus, a strong association among females before adjustment for socioeconomic position may simply be due to greater confounding among females. It may also be that different measures of SES mean different things or pick up on different mechanisms for males and females, in the way that levels of education (i.e. post-school qualification) may represent different constructs for male and females. But

this is outside the scope of this paper and analysis. Secondly, considering the association after adjusting for socioeconomic confounders, if there was differential misclassification of SES (or measurement error) by gender, whereby SES is more accurately measured in males compared to females, then the amount of gender varying residual confounding remaining, after adjusting for SES, may give rise to a spurious statistical interaction with gender (Greenland, 1980; Rothman et al., 2008). It is important that these complexities in the relationships are considered to enable a clearer understanding of the association of food security on mental health and any gender differences. We return to these issues in the Discussion.

We use a large, representative sample in NZ to determine the association of food security with psychological distress and whether the association persists after control of confounding by demographic and socioeconomic factors. We then examine how these associations differ by gender and how socioeconomic factors vary the associations.

Methods

Data

This study is a cross-sectional analysis utilising data from the longitudinal Survey of Families, Income and Employment (SoFIE) conducted in NZ from 2002-2010 (SoFIE data Wave 1 to 4 Version 6) (Carter et al., 2010a). Briefly, SoFIE is a representative household panel survey of the usually resident population living in private dwellings. In SoFIE, face to face interviews are used to collect information annually on income levels, sources and changes, and on the major influences on income such as employment and education experiences, household and family status and changes, demographic factors and health status. The initial SoFIE sample comprised approximately 11,500 responding private households (response rate of 77%) with over 22,000 adults responding in Wave 1, reducing to just over 20,000 in Wave 2 (91%) and over 18,000 in Wave 3 (83% of Wave 1 responders). Ethics for the SoFIE-Health study was obtained from the University of Otago Human Ethics Committee.

Measures

The main outcome measure was level of non-specific psychological distress at Wave 3, based on the Kessler-10 scale (K-10) (Andrews et al., 2001; Kessler et al., 2002; Kessler et al., 2003a), which asks about negative emotional states experienced in the four weeks prior to interview. The scores were grouped into four levels: low (10-15), moderate (16-21), high (22-29), and very high (30+) (Andrews et al., 2001). This was dichotomised at low versus moderate to very high for regression modelling.

The main exposure of interest was a composite (non-standard) measure of food security taken from three out of eight questions asked at Wave 3 that make up a New Zealand-specific measure of individual deprivation (NZiDep) (Salmond et al., 2005):

- In the last 12 months have you personally made use of special food grants or food banks because you did not have enough money for food? (yes/no)
- In the last 12 months have you personally been forced to buy cheaper food so that you could pay for other things you needed? (yes/no)
- In the last 12 months have you personally gone without fresh fruit and vegetables often so that you could pay for other things you needed? (yes/no)

If someone answered yes to any of these three questions, we classified them as food insecure. The majority of people classed as food insecure reported they had been forced to buy cheaper food and over 20% of the food insecure group had used food banks in the last 12 months (Carter et al., 2010b).

Demographic confounders were taken from the Wave 3 interview: age, gender, prioritised ethnicity, legal marital status (never legally married, divorced/separated/ widowed, and legally married), and family composition (couple only, couple with children, sole parent, not in a family nucleus).

Socioeconomic confounders were also taken from the Wave 3 interview and considered as confounders in the current analyses. Household income was derived by totalling adult annual personal income (before tax) from all sources received, CPI adjusted, equivalised for household economies of scale using a NZ-specific Jensen Index (Jensen, 1988), and categorised into quintiles. Labour force

involvement was defined as being either employed, not employed but seeking work, or not employed and not seeking work, at the time of the interview. The highest level of education was coded as nil, school, post-school vocational, or degree or higher qualification. The NZ Deprivation (NZDep2001) index provides a neighbourhood-level deprivation score (Salmond et al., 2002). Two other questions taken from the NZ measure of individual deprivation were included in the analyses:

- In the last 12 months have you continued wearing shoes with holes in them because you could not afford to replace them? (yes/no)
- In the last 12 months have you put up with feeling cold to save on heating costs? (yes/no)

Statistical Analysis

All analyses were conducted using SAS 8.2 within the Statistics NZ Data Laboratory, Wellington. Logistic regression analyses were used to investigate the association of food insecurity with psychological distress, comparing K-10 scores low (10-15) versus moderate to high (>15). A staged approach was used where demographic and socioeconomic confounders were added to sequential models. These models were repeated including an interaction between food security and gender. The final interaction model included main effects and interactions of gender with covariates that had a p-value of < 0.1, using backwards selection strategy.

The final models were stratified by gender to investigate differences in the association of food security with psychological distress in males and females and how much of the association is explained by including demographic and socioeconomic factors into the model. The change in odds ratios after adjusting for additional variables at each step was calculated by $(OR_i - OR_{i-1}) / (OR_{i-1} - 1)$. The Hausman test was used to test for a significant change in the food security to psychological distress odds ratio after adjustment for confounding variables at each step of the model building (Greenland, 2008). We used the Wald test for heterogeneity in the results between males and females (Rothman et al., 2008). This was compared to the final model including interactions term of gender with the covariates in the model.

Results

A total of 18,955 original sample members, aged 15 years or older, were interviewed in Wave 3 of SoFIE. There were 860 respondents with missing information on psychological distress (N=18,090).

Table 1 shows the crude association between food insecurity and the four levels of psychological distress. Much higher proportions of food insecure respondents reported moderate to high levels of psychological distress compared to those who were food secure. This is consistent across males and females, with females reporting slightly higher levels of psychological distress than males.

Table 2 shows the distribution of demographic and socioeconomic variables by low versus moderate to very high levels of psychological distress. High proportions of respondents with moderate to high levels of psychological distress were evident among the younger age groups, not NZ European ethnicity, sole parents, living in multi-person or multi-family households, lower socioeconomic groups (not holding a degree qualification, not working, living in deprived neighbourhoods, in the lower income and wealth quintiles), and reporting fair to poor self-rated health status.

Table 3 presents the results of logistic regression modelling of the odds of food insecurity on moderate to high levels of psychological distress in the overall population and by gender. There was a three-fold increase in the crude odds of moderate to high levels of psychological distress in food insecure respondents (OR 3.4 95%CI 3.1-3.7). The odds reduced after adjusting for demographic and socioeconomic confounders and socioeconomic variables but the association between food insecurity and psychological distress remained statistically significant (OR 2.6 95%CI 2.3-2.8, p-value <0.01). Further adjustment for individual-level deprivation variables (e.g. wore shoes with holes in them and put up with the cold to save on heating) resulted in a further decrease in the odds (OR 1.9 95%CI 1.7-

2.1, p -value < 0.01). The change in excess odds from the crude to the final model (not including health) was 61% overall.

An interaction between food insecurity and psychological distress was added to the final full model and was found to be non-significant (p -value = 0.31). However, this result did not control for gender differences in the association of other factors such as labour market activity and income, with psychological distress. Therefore, Table 4 presents the final model including interactions between gender and other covariates in the model with a p -value < 0.1 . In this model the interaction between gender and food insecurity was marginal (p -value = 0.06). Substantively, exponentiating the coefficients in Table 4, the OR for psychological distress associated with food insecurity among males is 1.70 (95% CI 1.43-2.01), but the similar OR among females is greater by a factor of 1.22 than for males. More directly the OR for psychological distress for food insecurity among females is 2.06 (i.e. 1.70×1.22).

The models were stratified by gender (presented in Table 3) to investigate gender differences in how much of the association between food security and psychological distress was explained by adjusting for socioeconomic factors. Table 3 shows that the strength of association was always less for males. The 95% confidence intervals overlapped for Models 1 to 3 and Wald tests of departure from homogeneity of the ORs by gender were not statistically significant. However, after adjustment for individual-level deprivation variables, there was a marked reduction in the OR: 2.3 to 1.6 for males, and 2.7 to 2.1 for females. Whilst confidence intervals for these adjusted ORs overlapped, the Wald test of departure from homogeneity was statistically significant ($p=0.03$), slightly smaller than found in the interaction model due backwards model selection used in the interaction model. The change in odds was much greater in males than females (change of 71% reduction in males, 54% reduction in females), which was mainly influenced by the addition of the socioeconomic and NZiDep variables.

Discussion

We have shown a strong crude association between food insecurity and psychological distress in the NZ population. This association was largely

explained by adjusting for confounding demographic and socioeconomic variables. Nevertheless, a 60% (males) to 110% (females) elevated odds of psychological distress among those reporting food insecurity remained. A strength of this study is the ability to adjust for many confounding socioeconomic factors. But given that adjusting for socioeconomic factors halved the strength of the association the question remains as to whether the association would disappear to the null if adjusted for perfectly measured, and including even more, socioeconomic factors. Therefore, it is possible that the final results were still residually confounded. However, given the large range of socioeconomic factors that we adjusted for, it would be surprising if “better” adjustment would reduce the association completely to the null.

Assuming our results represent some causal association of food security with psychological distress, they are consistent with previous research on, although we use a broad definition of food security. The longitudinal study by Siefert et al. found a doubling in the odds of major depressive disorder as a result of becoming food insufficient (Siefert et al., 2004). Other cross-sectional studies found similar associations between food insecurity and mental ill-health (Casey et al., 2004; Laraia et al., 2006; Whitaker et al., 2006).

However, much of the previous research investigated the relationship between food security and mental health using study populations comprising females only (Casey et al., 2004; Collins, 2009; Heflin et al., 2005; Huddleston-Casas et al., 2009; Kaiser et al., 2007; Klesges et al., 2001; Laraia et al., 2006; Siefert et al., 2001, 2004; Whitaker et al., 2006) . Building upon these studies, our results suggest that the relationship between food insecurity and psychological distress was notable in males as well as in females, although the relationship was apparently stronger among women than men. However, this relationship was confounded by SES. Our results demonstrated that demographic and SES factors explained more of the relationship between food insecurity and psychological distress in men than in women.

As discussed earlier, there may be differential misclassification of SES between males and females, leading to differing amounts of residual confounding

by gender. If this is strong enough, it may induce a statistical interaction with gender where it would not necessarily occur (Greenland, 1980; Rothman et al., 2008). This may be the case in our study. However, we were able to control for multiple measures of SES in our models, which should mitigate against residual confounding by socioeconomic position (Fewell et al., 2007). This inclusion of multiple measures probably reduces opportunity for variation in residual confounding by SES by gender. However, we cannot rule out unmeasured confounding due to factors that we could not adjust for in the model that may be correlated with food security and gender.

The strengths of our study may, in certain aspects, also bring limitations to the analysis. Potential misclassification of our exposure and outcome, (food security and psychological distress), may have led to underestimation of the true association. Our exposure measure of food insecurity is not based on a standardised measure and therefore is broader and less extreme than other measures of food insecurity or food insufficiency used in other research (Alaimo et al., 1998; Siefert et al., 2004; Vozoris et al., 2003). Other studies have used standardised measures of food security developed by the United States Department of Agriculture's 18-question food security scale (Carlson et al., 1999; Casey et al., 2004; Laraia et al., 2006; Stuff et al., 2004), including a 6-question subset of that scale (Kaiser et al., 2007). The advantage of our measure is that we are capturing a population that is experiencing hardship in acquiring adequate nutritious food and, as a result, may suffer from poor health outcomes.

Our measure of food insecurity is based on the concept that refers to the social and economic problem of lack of food due to financial deprivation, and it does not tap into facets of hunger. The questions used to create our measure of food security were taken from a standardised index of individual deprivation for NZ (Salmond et al., 2005). We compared the prevalence of food insecurity in the SoFIE population with other NZ studies and found similar prevalence across key factors. The proportion of respondents reporting that they had used food banks or food grants in the last 12 months (4%), a measure commonly used to define food security at a population level, was the same as the National Nutrition Survey (Russell et al., 1999) but less than the 9% found in the Child Nutrition Survey

(Ministry of Health, 2003). We found similar trends across ethnic groups, with Māori and Pacific households and people living in deprived areas (measured by the NZ Deprivation index) reporting higher levels of food insecurity (Carter et al., 2010b).

It has been argued that feelings of stress are inherently implied in indicators of food security (Quigley et al., 1997), which could lead to strong associations due to their overlapping constructs. The NZ Nutrition surveys explicitly include questions about whether a household feels stressed because of not having enough money for food, or can't provide the food needed for social occasions (Ministry of Health, 2003; Quigley et al., 1997; Russell et al., 1999). However, our composite measure of food security is based at the individual level and does not include any questions about feeling stressed because of lack of food – a relative strength of our study.

We used a measure of non-specific psychological distress as the outcome, while previous studies typically have used a clinical definition of depression. Therefore, our results are more reflective of the association of food security with subjective mental health across a range of symptoms and severity. From a recent NZ mental health survey, people with high Kessler 10 scores (>21) were much more likely to be diagnosed with a mental disorder in the past 12 months (M.A. Oakley Browne et al., 2010). The sensitivity of the Kessler 10 was tested by dichotomising it at low, moderate versus high, very high (10-21 versus 22+) and the associations were stronger, meaning that food insecurity is an even stronger predictor of adverse mental health states. Therefore, the results we present are conservative associations, which may underestimate of the association between food insecurity and mental disorders.

Although the SoFIE-Health Study is longitudinal, our analysis was on one wave of data only (i.e. cross-sectional). It has been shown in previous analyses of the SoFIE data that attrition (dropping out of the sample up to Wave 3) was greater in younger participants, those reporting ethnicity other than NZ European, poorer health status and lower socioeconomic status (low income, unemployed, living in highly deprived areas) (Carter et al., 2010a). However, it is unlikely that this would

have had an effect on the cross-sectional association between food security and psychological distress, and even less likely on the gender differences between them. Previous literature has shown that even when there is differential participation in surveys by individual covariates, this does not necessarily influence the exposure-outcome relationship (Batty et al., 2009; de Winter et al., 2005; Powers et al., 2010), which requires non-participation to vary jointly (or dependently) by the exposure and outcome (i.e. selection bias).

Once additional waves of SoFIE-Health data are available, we will investigate in more depth the causal pathway between food security and psychological distress. Using fixed effects regression techniques on the longitudinal data will allow us to unpack the causal association between food security and psychological distress controlling for unobserved confounders (Wooldridge, 2002). More detailed research on the differing roles of males and females and the impacts on food security and subsequent mental health is needed. Qualitative research asking people about their roles within the household and the physical and mental impact of not being able to afford enough food for a healthy lifestyle will help us to understand these complex relationships better (Bowers et al., 2009; Hamelin et al., 2002; Hamelin et al., 2008; Maes et al., 2010).

Conclusion

We have observed that food insecurity is strongly associated with psychological distress in both males and females, independently of socioeconomic confounders. Assuming at least some of this observed association is causal (i.e. not all due to residual confounding). We also found evidence suggestive of a slightly stronger association in females, although this needs further scrutinising by other research. These results add further impetus over and above nutritional grounds for public health policy and action to reduce food insecurity. By implementing interventions that enhance food security in at-risk households, improvements in both physical and mental health may follow.

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Table 1. Food security and psychological distress, overall and by sex

Food Insecurity	N	Low		Moderate			High			Very High			
		N	row %	col %	N	row %	col %	N	row %	col %	N	row %	col %
Total	18085	14120	78.1		2720	15.0		945	5.2		300	1.7	
No	15120	12415	82.1	87.9	1995	13.2	73.3	580	3.8	61.4	130	0.9	43.3
Yes	2965	1705	57.5	12.1	725	24.5	26.7	365	12.3	38.6	170	5.7	56.7
Male													
Total	8315	6685	80.4		1155	13.9		385	4.6		90	1.1	
No	7305	6075	83.2	90.9	925	12.7	80.1	260	3.6	67.5	45	0.6	50.0
Yes	1010	610	60.4	9.1	230	22.8	19.9	125	12.4	32.5	45	4.5	50.0
Female													
Total	9770	7435	76.1		1565	16.0		560	5.7		210	2.1	
No	7815	6340	81.1	85.3	1070	13.7	68.4	320	4.1	57.1	85	1.1	40.5
Yes	1955	1095	56.0	14.7	495	25.3	31.6	240	12.3	42.9	125	6.4	59.5

The numbers of respondents are random rounded to the nearest multiple of five, with a minimum value of 10, as per Statistics New Zealand confidentiality protocol.

Table 2. Demographic and socioeconomic variables by dichotomised psychological distress

	Psychological Distress				
		Low		Mod to Very High	
		N	%	N	%
	18090	14120	78.1	3970	21.9
Food insecure					
No	15120	12415	82.1	2705	17.9
Yes	2970	1705	57.4	1265	42.6
NZiDep - Had to go without fruit and vegetables often					
No	17655	13940	79.0	3715	21.0
Yes	435	180	41.4	255	58.6
NZiDep - Forced to buy cheaper food					
No	15265	12495	81.9	2770	18.1
Yes	2825	1625	57.5	1200	42.5
NZiDep - Forced to use food grants or food banks					
No	17455	13835	79.3	3620	20.7
Yes	635	285	44.9	350	55.1
Sex					
Male	8740	7720	88.33	1020	11.67
Female	10215	8235	80.62	1980	19.38
Age					
15-24	2755	1980	71.9	775	28.1
25-34	2560	1940	75.8	620	24.2
35-44	3610	2795	77.4	815	22.6
45-54	3390	2745	81.0	645	19.0
55-64	2680	2195	81.9	485	18.1
65-74	1715	1400	81.6	315	18.4
75+	1380	1065	77.2	315	22.8
Marital Status					
Never Married	5460	3995	73.2	1465	26.8
Divorced Widowed Separated	3170	2365	74.6	805	25.4
Married	9445	7750	82.1	1695	17.9
Prioritised Ethnicity					
NZ/European	14165	11290	79.7	2875	20.3
Maori	1940	1405	72.4	535	27.6
Pacific	765	520	68.0	245	32.0
Asian	905	685	75.7	220	24.3
Other	305	215	70.5	90	29.5
Family Status					
Couple Only	5195	4255	81.9	940	18.1
Couple with children	7345	5870	79.9	1475	20.1
Sole parent	1740	1190	68.4	550	31.6
Not in a family nucleus	3805	2800	73.6	1005	26.4
Household Composition					
One Family	13980	11100	79.4	2880	20.6
Two or more families	565	405	71.7	160	28.3
Other multi-person household	1000	715	71.5	285	28.5
One person ho	2535	1895	74.8	640	25.2
Geographic region					
Auckland	4500	3475	77.2	1025	22.8
Waikato	1650	1335	80.9	315	19.1
Wellington	2360	1875	79.4	485	20.6

Rest of North	4070	3200	78.6	870	21.4
Canterbury	2935	2245	76.5	690	23.5
Rest of South	2575	1990	77.3	585	22.7
Been unemployed for 4 weeks or more					
No	17380	13650	78.5	3730	21.5
Yes	710	470	66.2	240	33.8
Received income tested benefits in past 12 months					
No	16210	13025	80.4	3185	19.6
Yes	1880	1095	58.2	785	41.8
Maximum Qualification					
No Qualification	4455	3320	74.5	1135	25.5
School Qualification	4850	3745	77.2	1105	22.8
Post school	6215	4910	79.0	1305	21.0
Degree	2570	2145	83.5	425	16.5
Labour Market Activity					
Working	11830	9655	81.6	2175	18.4
Not employed, looking for work	330	200	60.6	130	39.4
Not Employed, not looking	5925	4260	71.9	1665	28.1
NZiDep - Put up with the cold					
No	16190	13055	80.6	3135	19.4
Yes	1900	1065	56.1	835	43.9
NZiDep - Worn shoes with holes					
No	17275	13735	79.5	3540	20.5
Yes	815	385	47.2	430	52.8
NZ Deprivation					
Q1 (least deprived)	3700	3160	85.4	540	14.6
Q2	3680	2990	81.3	690	18.8
Q3	3335	2625	78.7	710	21.3
Q4	3850	2860	74.3	990	25.7
Q5 (most deprived)	3515	2480	70.6	1035	29.4
Household Income					
Q1	2060	1425	69.2	635	30.8
Q2	4210	3050	72.4	1160	27.6
Q3	3515	2680	76.2	835	23.8
Q4	3890	3200	82.3	690	17.7
Q5	4420	3765	85.2	655	14.8
Self-Rated Health					
Excellent	6355	5365	84.4	690	10.9
Very Good	6440	4985	77.4	1190	18.5
Good	4235	2910	68.7	1145	27.0
Fair	1470	735	50.0	655	44.6
Poor	440	125	28.4	280	63.6

NZiDep – NZ index of individual deprivation

The numbers of respondents are random rounded to the nearest multiple of five, with a minimum value of 10, as per Statistics New Zealand confidentiality protocol.

Table 3 Logistic regression odds ratios (OR) and 95% confidence intervals of moderate to high psychological distress in the food insecure group.

Model	Overall	<i>Change**</i>	Males	<i>Change**</i>	Females	<i>Change**</i>	P-value for Wald test of heterogeneity
1. CRUDE	3.4 (3.1-3.7)		3.2 (2.8-3.7)		3.4 (3.1-3.8)		0.46
2. + Demographics	3.0 (2.8-3.3)	-0.15	2.9 (2.5-3.4)	-0.14	3.1 (2.8-3.5)	-0.11	0.47
3. + Socioeconomic	2.6 (2.3-2.8)	-0.24	2.3 (2.0-2.7)	-0.30	2.7 (2.4-3.1)	-0.20	0.16
4. + NZiDep*	1.9 (1.7-2.1)	-0.41	1.6 (1.4-2.0)	-0.53	2.1 (1.8-2.4)	-0.35	0.03

Demographic Confounders = Age, Sex, Ethnicity, Marital Status, Family composition

Socioeconomic Confounders = Household income, Labour Market Activity, Level of Education, NZ (area) Deprivation

*NZiDep NZ index of individual deprivation Confounders = Worn shoes with holes in them, put up with the cold to save on heating costs

** Change = $(OR_i - OR_{i-1}) / (OR_{i-1} - 1)$.

Table 4 Logistic regression results for the food insecurity and psychological distress model, covariates selected using backward selection, including interactions between gender and covariates (with p-value < 0.1).

Variable	Class Value	Estimate	StdErr	P-Value
Food Insecurity	Yes	0.529	0.086	<0.0001
Sex	Female	0.365	0.105	0.0005
Sex*Food Insecurity	Female*Yes	0.195	0.104	0.0616
Age	25-34	-0.248	0.109	<0.0001
Age	35-44	-0.362	0.100	
Age	45-54	-0.200	0.103	
Age	55-64	-0.319	0.110	
Age	65+	-0.695	0.113	
Sex*Age	Female*25-34	-0.248	0.140	0.0496
Sex*Age	Female*35-44	-0.362	0.130	
Sex*Age	Female*45-54	-0.241	0.134	
Sex*Age	Female*55-64	-0.273	0.142	
Sex*Age	Female*65+	-0.020	0.142	
Ethnicity	Maori	-0.140	0.097	0.3900
Ethnicity	Pacific	0.099	0.137	
Ethnicity	Asian	-0.050	0.135	
Sex*Ethnicity	Female*Maori	0.222	0.123	0.0434
Sex*Ethnicity	Female*Pacific	0.176	0.174	
Sex*Ethnicity	Female*Asian	0.396	0.173	
Family Status	Couple with children	-0.144	0.057	<0.0001
Family Status	Sole parent	-0.090	0.077	
Family Status	Not in a family	0.130	0.057	
Labour Market Activity	Unemployed	0.477	0.182	<0.0001
Labour Market Activity	Inactive	0.769	0.080	
Sex*Labour Activity	Female*Unemployed	0.164	0.251	<0.0001
Sex*Labour Activity	Female*Inactive	-0.461	0.099	
Education	No Qualification	0.287	0.074	0.0014
Education	School Qual	0.189	0.070	
Education	Post School Qual	0.210	0.068	
HHLI Income	Q1	0.104	0.076	0.0002
HHLI Income	Q2	0.251	0.065	
HHLI Income	Q3	0.197	0.064	
HHLI Income	Q4	0.033	0.063	
NZ Deprivation	NZDepQ2	0.222	0.066	<0.0001
NZ Deprivation	NZDepQ3	0.249	0.067	
NZ Deprivation	NZDepQ4	0.435	0.064	
NZ Deprivation	NZDepQ5	0.392	0.069	
Save Heating	Yes	0.509	0.061	<0.0001
Worn out shoes	Yes	0.872	0.167	<0.0001
Sex*Worn out shoes	Female*Yes	-0.356	0.130	0.0332

- The association between food insecurity and psychological distress in New Zealand remained after adjustment for multiple demographic and socioeconomic confounding factors.
- An independent association of food insecurity with psychological distress was found in both males and females.
- Food insecure females had slightly higher odds for psychological distress than males, though this difference was of marginal significance.