

Food insecurity among adults residing in disadvantaged urban areas: potential health and dietary consequences

Rebecca Ramsey*, Katrina Giskes, Gavin Turrell and Danielle Gallegos
School of Public Health, Queensland University of Technology, Victoria Park Avenue, Kelvin Grove,
Queensland 4059, Australia

Submitted 21 September 2010: Accepted 3 June 2011: First published online 7 September 2011

Abstract

Objective: Food insecurity is the limited or uncertain availability or access to nutritionally adequate, culturally appropriate and safe foods. Food insecurity may result in inadequate dietary intakes, overweight or obesity and the development of chronic disease. Internationally, few studies have focused on the range of potential health outcomes related to food insecurity among adults residing in disadvantaged locations and no such Australian studies exist. The objective of the present study was to investigate associations between food insecurity, socio-demographic and health factors and dietary intakes among adults residing in disadvantaged urban areas.

Design: Data were collected by mail survey (n 505, 53% response rate), which ascertained information about food security status, demographic characteristics (such as age, gender, household income, education) fruit and vegetable intakes, takeaway and meat consumption, general health, depression and chronic disease.

Setting: Disadvantaged suburbs of Brisbane city, Australia, 2009.

Subjects: Individuals aged ≥ 20 years.

Results: Approximately one in four households (25%) was food insecure. Food insecurity was associated with lower household income, poorer general health, increased health-care utilisation and depression. These associations remained after adjustment for age, gender and household income.

Conclusions: Food insecurity is prevalent in urbanised disadvantaged areas in developed countries such as Australia. Low-income households are at high risk of experiencing food insecurity. Food insecurity may result in significant health burdens among the population, and this may be concentrated in socio-economically disadvantaged suburbs.

Keywords
Food insecurity
Health consequences
Health outcomes
Dietary consequences

Food insecurity is the limited or uncertain availability or access to nutritionally adequate, culturally relevant and safe foods^(1–3). It is a dynamic condition and its prevalence may vary by location and time depending on a range of factors^(4–6). Studies undertaken in developed countries over the last 12 years have shown that the prevalence of food insecurity ranges from 4 to 14% among population-representative samples⁽⁷⁾ and up to 82% among disadvantaged groups such as ethnic minorities and single-parent families^(3,7–12).

The major predictor of food insecurity is low income or poverty, which limits financial resources for acquiring food^(10,13–15). Other potential determinants of food insecurity include belonging to an ethnic minority^(10,16–18), having a lower level of education^(10,15–17), being of younger age^(16,19) and family type (single-parent family *v.* couples with children)^(9,10,14,20). Food insecurity may be associated with lower fruit and vegetable intakes^(21–25), lower consumption of lean meats^(21,23), poorer general

health^(13,20,21,23,26–29), chronic conditions such as CVD^(20,30–32) and depression^(26,27,33–37), and overweight or obesity among women^(38–44). There are several hypothesised mechanisms through which food insecurity may be associated with these factors. Budgetary constraints may result in decreased intakes of fruits, vegetables and lean meats, which are perceived to be expensive and less satisfying^(45–47), and increased intakes of energy-dense foods^(45–47). These changes may contribute to the development of overweight, obesity or poor health. Food insecurity may also result in a pattern of fasting and bingeing as a consequence of cyclical access to money; this pattern may lead to excess weight gain^(45,48). Corresponding nutrient deficiencies (due to dietary changes), metabolic changes and accompanying stress may, in turn, lead to the development of chronic diseases such as CVD, diabetes or depression, which may result in increased utilisation of health-care services⁽⁴⁹⁾. An alternative hypothesis is that poorer general health, depression and

*Corresponding author: Email rebecca.ramsey@qut.edu.au

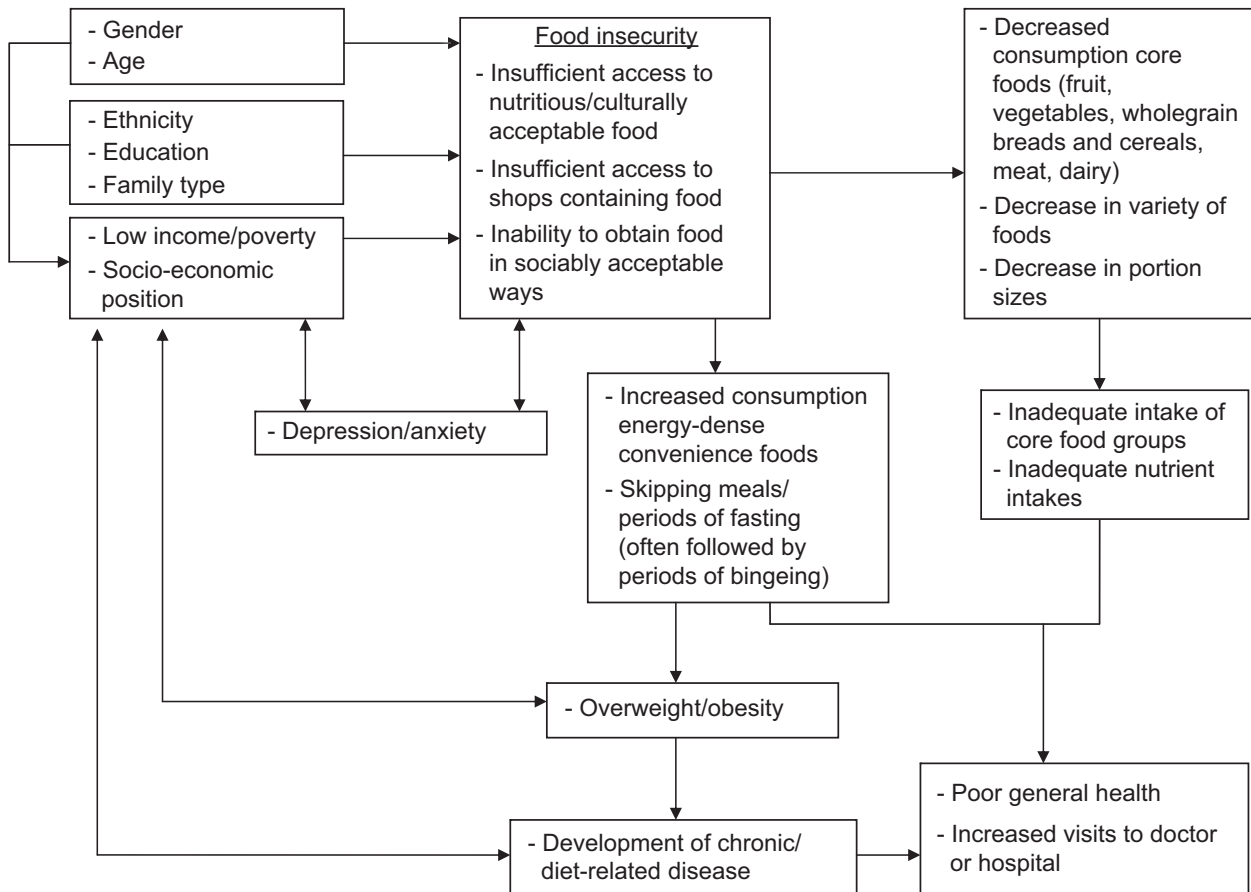


Fig. 1 Hypothesised relationships between food security, dietary and health outcomes

chronic disease may result in debilitation, decreased participation in the workforce and, consequently, lower earning capacity or material disadvantage which may contribute to the development of food insecurity. Figure 1 details the hypothesised associations between food insecurity, socio-demographic characteristics, diet, and health outcomes.

Within Australia, screening for food insecurity occurs via a single question in the National Health Survey (NHS), undertaken every three years. Between 1995 and 2004, the rate of food insecurity among the Australian population remained steady at approximately 5%. Due to the perceived low prevalence of food insecurity, screening was not undertaken in the most recent NHS (2007/08). A comparison of the single-item NHS measure with the more comprehensive US Department of Agriculture Food Security Survey Module (USDA-FSSM) has suggested that the single item may underestimate food insecurity by approximately 5%. Within Australia specifically, a limited number of studies have investigated the factors associated with food insecurity. Findings suggest that socio-demographic characteristics, including low levels of income, limited financial resources, poor capacity to save money or being unemployed, may be predictors of food insecurity^(21,50–52). Furthermore, living alone or being of

single marital status^(21,51,52), experiencing poor health or disability^(50–52) and renting as opposed to being a home owner^(50,51) were factors potentially associated with food insecurity.

Few studies internationally have examined how a broad range of health behaviours and health risk factors are associated with food insecurity and no known Australian studies exist investigating these. The recent financial crisis co-occurred with a food crisis, creating an unprecedented rise in the prevalence of food insecurity internationally through a combination of increasing domestic food prices, decreased income and higher rates of unemployment^(53,54). It is envisaged, therefore, that the health and social burdens of food insecurity may increase worldwide, particularly among socio-economically disadvantaged groups^(53,54).

Despite the increasing global salience of food insecurity, most studies investigating its potential consequences have been conducted in the USA. Most studies outside the USA have primarily utilised crude, one-item indicators of food security which have been shown to underestimate the prevalence of food insecurity, limiting their ability to assess food security status^(50,55). The range of measures of food insecurity applied outside the USA has further restricted

the comparability of the prevalence of food insecurity between countries, limiting our understanding of the implications of food insecurity in other developed nations.

To date, most studies that focused on food insecurity have examined either a population-representative sample or population subgroups at increased risk, such as ethnic minorities or single-parent households. Few studies have examined the prevalence and potential consequences of food insecurity in geographical areas of concentrated socio-economic disadvantage. This is of significance, given that: (i) health promotion strategies and welfare agencies are increasingly servicing defined geographic areas; and (ii) efforts to improve health are increasingly being tailored to areas^(56,57).

The current study addresses these limitations in understanding the sociodemographic, dietary and health factors associated with food insecurity and builds on current food security knowledge as it examines the prevalence, health and health-related behaviours associated with food insecurity among residents of socio-economically disadvantaged urban areas in Australia. It also examines several aspects of health that have previously been investigated in disparate studies.

Methods

The present study was approved by the Queensland University of Technology ethics committee (approval number 0800000735).

Study scope and sampling

The study was conducted in the Brisbane Statistical Sub-Division, Australia. The sampling of individuals was undertaken in a two-stage procedure. The first stage involved the identification of the most disadvantaged 5% of census collector districts (CCD) in Brisbane, according to each CCD's Index of Relative Socioeconomic Disadvantage (IRSD). The IRSD is derived from the Australian Bureau of Statistics using census variables related to advantage and disadvantage (including income, education and employment). The IRSD reflects a continuum of disadvantage through advantage, with lower values indicative of greater disadvantage⁽⁵⁸⁾.

Stage two of the sampling involved selecting 1000 individuals aged between 25 and 45 years from households within these CCD. Individuals between these ages were selected in order to capture the age group with the greatest likelihood of having a residential child (related to a subsequent aim of the study); however, the final age of respondents ranged between 20 and 59 years. Data providing name, gender, age and address were accessed via the electoral roll (voting is compulsory for all adults above 18 years of age in Australia). The electoral roll for the Brisbane Statistical Sub-Division was geocoded to the selected CCD using MapInfo version 11.5 software

(MapInfo Corporation, Troy, NY, USA) and households within these CCD were identified. A total of 1000 households were then randomly selected to participate in the study.

Participants and data collection

Data collection occurred between March and May 2009. Individuals were contacted about their participation in the study using the mail-out method developed by Dillman⁽⁵⁹⁾. All selected individuals were offered a small financial gratuity comprising a \$AU 1 lottery ticket. The questionnaire was twelve pages in length, comprised primarily of previously validated items, and sought information on dietary and health factors, household food security status and sociodemographic information.

Food security status

Food security was assessed using the USDA-FSSM. This is an eighteen-item food security screening questionnaire with reliability of $\alpha = 0.75$ in the current sample, and categorises households as: (i) food secure, (ii) low level of food security, (iii) very low level of food security and (iv) very low level of food security among children. As the proportions of households experiencing each individual level of food security were small (11.1% low level of food security, 12.7% very low level of food security and 0.8% very low level of food insecurity among children), this variable was dichotomised as 'food secure' or 'food insecure'.

Sociodemographic characteristics

Data on gender, age, country of birth, equivalised household income, family type and indigenous status were collected. Participants were asked to indicate their gender ('male' or 'female') and indigenous status ('non-Indigenous' or 'Aboriginal or Torres Strait Islander'). To determine country of birth, participants were asked to record the country in which they were born. These were categorised into 'Oceanic/Antarctica', 'Europe', 'Africa and the Middle East', 'Asia' and 'the Americas'. Age was reported as a continuous variable then categorised for analyses. Participants were also asked to report their total gross household income. Equivalised income was then calculated as per the methods employed by the Australian Bureau of Statistics. First, individuals within the household were provided weightings (1 for the first adult, 0.5 for consecutive adults, 0.5 for the first child and 0.3 for each consecutive child). Each weighting was multiplied by the number of corresponding adults or children and then summed⁽⁶⁰⁾. The income mid-point for each category was then divided by this number and categorised into tertiles, with the lowest tertile indicating the lowest income per household unit.

Fruit and vegetable intakes

Intakes of fruits and vegetables (including potatoes) were assessed using short answer questions from the Australian NHS⁽⁶⁰⁾. Participants were asked 'How many pieces of

fruit do you usually eat per day?' and 'How many servings of vegetables do you usually eat per day?' Responses to this item were categorised as: '1 serving per day or less', '2 servings per day' or '3+ servings per day'.

Meat consumption

Questions relating to meat consumption were modified from those used in the Queensland Cancer Risk Study⁽⁶¹⁾. Participants were asked to report on their usual weekly consumption of red meat, fish, chicken and processed meats (such as sausages, salami, etc.; e.g. 'How many times per week do you eat red meat?'). Responses were categorised as 'never/less than once per week', 'one to two times per week' or 'three or more times per week'.

Takeaway consumption

Takeaway consumption was measured using items modified from the 1995 Australian National Nutrition Survey (NNS; the most recent NNS to date)⁽⁶²⁾. These items measured the frequency of consumption of potato chips, fries or wedges, hamburgers, Chinese food, pizza, cakes, savoury pies, fried fish and fried chicken; these were the ten most popular takeaway items consumed by the Australian population⁽⁶²⁾. Responses were coded as 'never/ rarely', 'less than once per week' and 'one or more times per week'.

Self-assessed health and depression

A single item asked participants to rate their overall health ('excellent', 'very good', 'good', 'fair' or 'poor'). The depression domain from the Short Form 12 (SF12; reliability of $\alpha = 0.79$ among this sample) was summed to provide a continuous scale which was categorised into tertiles to indicate risk of depression ('low', 'medium', 'high'); higher scores indicated higher risk of depression.

Chronic disease

Consistent with the NHS, participants were asked to indicate ('yes' or 'no') whether they had been told by a doctor, nurse or health professional that they had diabetes, high blood pressure, hardened arteries, high cholesterol or heart attack⁽⁶⁰⁾.

Weight status

Weight status was assessed using BMI. As per standard procedure in mail-based surveys, participants were asked to report their height and weight. BMI was calculated and categorised as underweight/normal weight (BMI < 25.00 kg/m²), overweight (BMI = 25.00 to 29.99 kg/m²) and obese (BMI \geq 30.00 kg/m²) using the WHO international classification for adults' BMI⁽⁶³⁾.

Covariates

Based on bivariate analyses, indigenous status, education, household income and family type were associated with food insecurity and were considered to be potential

confounding variables (Table 1). Chi-square analyses were undertaken to investigate the associations between these covariates and each of the potential outcomes to be investigated. Covariates that were associated with both food insecurity and the potential outcome at the bivariate level were adjusted for during multivariate analyses. As such, each analysis investigating the association between food insecurity and a specific outcome has uniquely adjusted for all relevant potential confounding variables. The covariates adjusted for during each analysis are summarised in the footnotes of Table 3.

Based on previous literature, gender was considered a potential effect modifier and results were initially stratified by gender. However, as there were no differences between results that were stratified for gender and those that were not and the direction of associations between food insecurity and potential outcomes were similar for both males and females, data were combined to provide more statistical power.

Data analyses

Data were analysed using the SPSS statistical software package version 16 (SPSS Inc., Chicago, IL, USA). Chi-square analysis was used to test for statistical significance between food security status and the sociodemographic and outcome variables. Binary and multinomial logistic regression analyses were then used to assess the potential determinants and outcomes of food insecurity controlling for the appropriate covariates. For variables with more than 5% of data missing, a separate category, 'missing', was created.

Results

Of the 1000 individuals sampled, three were unable to speak English, forty-nine no longer resided at the address listed on the electoral roll and one was overseas; these groups were therefore unable to complete the questionnaire, leaving 947 potential participants. Five-hundred and five completed questionnaires were returned, resulting in a final response rate of 53%.

Table 1 summarises the associations between socio-demographic characteristics and food insecurity. At the bivariate level, household income, indigenous status, education and family type were associated with food insecurity. After each of these variables was included in a logistic regression model, equalised household income was the only factor that remained significant.

Table 2 summarises the demographic and food security characteristics of participants in the study. The sample was comparable to the general population residing in the selected CCD in terms of gender and country of birth. Our sample included a slightly increased proportion of higher-income households than the general population. As we intentionally selected our sample according to age range,

Table 1 Association between food security status and sociodemographic covariates: individuals aged ≥ 20 years ($n = 487$) from disadvantaged suburbs of Brisbane city, Australia, 2009

Demographic characteristic	Food secure (%)	Food insecure (%)	P value	Food insecure (reference: food secure)	
				OR	95% CI
Gender					
Male	47.0	36.5			
Female	53.0	53.5	0.15		
Age group (years)					
20–29	17.8	14.3			
30–39	31.2	25.9			
40–49	33.2	41.1			
50–59	17.8	18.8	0.81		
Country of birth					
Oceanic/Antarctica	70.0	74.1			
Europe	7.1	7.8			
Africa & Middle East	2.6	2.6			
Asia	12.7	12.1			
Americas	2.0	0.0	0.10		
Equivalised household income					
Highest tertile	20.7	57.1		1.00	
Middle tertile	34.9	30.6		2.82*	1.37, 5.78
Lowest tertile	44.4	12.2	<0.01	8.96*	4.41, 18.21
Family type					
Couple, with children	49.2	45.9		1.00	
Couple, no children	30.0	12.9		1.29	0.71, 2.32
Single-parent family	20.8	41.1		1.79	0.99, 3.26
Single, no children			<0.01	1.03	0.46, 2.29
Indigenous status					
Non-indigenous	97.4	92.1		1.00	
Aboriginal or Torres Strait Islander	2.6	7.9	0.03	1.66	0.55, 5.07
Education					
Year 10/less	25.1	39.3		1.00	
Year 11–12	22.5	28.6		1.25	0.70, 2.23
Diploma/certificate/trade	28.6	20.5		0.71	0.38, 1.32
Bachelor's degree	15.6	8.9		0.62	0.27, 1.43
Postgraduate qualification	8.1	2.7	0.03	0.56	0.14, 2.14

*Significant at $P < 0.05$.

our sample differed slightly with regard to age distribution and household structure, with a lower proportion of individuals aged 20–29 years (17% in the study sample *v.* 28% in the general population of the eighty-two CCD) and higher proportions of individuals aged 40–49 years (35% *v.* 25%) and couples with children (49% *v.* to 37%). The prevalence of food insecurity was about 25%.

The diet and health characteristics and the results adjusted for sociodemographic covariates are summarised in Table 3. Although lower fruit and vegetable intakes were reported by those from food-insecure households, differences were not statistically significant.

There were no significant associations between food insecurity and meat consumption; however, the findings showed that food-insecure households were two-and-a-half times more likely to report more frequent hamburger consumption. For health outcomes, food insecurity was associated with a two- to threefold increase in having seen a general practitioner and with a twofold higher likelihood of being hospitalised within the last 6 months. A positive association was seen between food insecurity and poorer general health and depression; food insecurity was associated with a threefold increase in experiencing fair or poor general health and with a two- to sixfold

increase in likelihood of depression among respondents compared with those who were not food insecure. Weight status was not associated with food insecurity.

Discussion

Our findings showed that food insecurity was prevalent among adults residing in socio-economically disadvantaged areas of urbanised Australia. Food insecurity was associated with lower household income and multiple adverse health behaviours and outcomes, such as increased risk of depression, poorer general health and more frequent hospitalisations or visits to general practitioners. We did not find evidence that food insecurity was associated with other sociodemographic characteristics or with fruit and vegetable intakes, meat consumption, weight status or chronic disease among this sample. These findings suggest that food insecurity is a salient public health issue among residents of socio-economically disadvantaged areas outside the USA. Health promotion and welfare strategies aimed at improving food security status may need to address the increased rates of poor health, depression and health-service utilisation associated with

Table 2 Demographics and food security characteristics of the study sample (*n* 487) compared with the total population in the selected census collector districts (CCD), disadvantaged suburbs of Brisbane city, Australia, 2009

Demographic characteristic	Total study sample (%)	Total population of selected CCD in study (%)
Gender		
Male	44.5	48.5
Female	55.5	51.5
Age (years)		
Mean	40.4	
SD	9.0	
Age group (years)		
20–29	16.8	27.3
30–39	30.0	26.4
40–49	35.1	25.1
50–59	18.1	21.2
Country of birth		
Oceanic/Antarctica	74.4	75.3
Europe	7.4	8.6
Africa & Middle East	2.9	1.4
Asia	13.8	13.3
Americas	1.5	1.4
Equivalised household income		
≤\$AU 499	22.9	23.6
\$AU 500–\$799	17.7	25
\$AU 800–\$999	11.5	8.7
\$AU 1000–\$1399	16.2	22.5
\$AU 1400–\$2499	27.1	16.4
≥\$AU 2500	5.6	3.7
Family type		
Couple, no children	25.1	29.8
Couple, with children	49.2	37.4
Single-parent family	25.7	32.8
Indigenous status		
Non-indigenous	95.7	94.1
Aboriginal	3.5	5.1
Torres Strait Islander	0.5	0.4
Aboriginal and Torres Strait Islander	0.3	0.4
Education		
Year 10/less	28.6	
Year 11–12	24.5	
Diploma/certificate/trade	26.1	
Bachelor's degree	13.9	
Postgraduate qualification	6.8	
Food security status		
Food secure	71.3	
Low level of food security	11.1	
Very low level of food security	12.7	
Very low level of food security among children	0.8	

food insecurity to reduce the potential burden of these health and social consequences in such areas.

As expected, lower household income was associated with food insecurity. This is likely due to fewer financial resources with which to acquire food (resulting in food insecurity). At the bivariate level, indigenous status, education and family type were also associated with food insecurity. However, these associations were no longer statistically significant after adjustment for income. This may suggest that these factors affect food security status indirectly through income, rather than directly.

Consistent with previous findings, we found that food insecurity was associated with poorer general health^(13,20,21,23,26–29), increased risk of depression^(26,27,33–37) and more frequent hospitalisations and visits to general practitioners^(64,65). There are two hypothesised pathways

by which food insecurity may be associated with adverse health, including (i) physiological and psychological changes due to nutrient deficiencies and (ii) the stress and anxiety experienced as a result of being unable to access sufficient amounts of food. Alternatively depression and poor health may limit participation in the workforce, lowering earning capacity and contributing to the development of food insecurity^(20,27,33,35). The direction of these associations is unclear; to date, studies examining these issues have been cross-sectional, with the exception of two^(27,35) that suggested that food insecurity may be a precursor to depression.

We did not find an association between food insecurity, fruit and vegetable and meat intakes among our sample. Those from food-insecure households reported more frequent consumption of hamburgers, but not other

Table 3 Diet and health characteristics (%) according to food security status and adjusted associations (odds ratios and 95% confidence intervals) between health and dietary outcomes and food security status: individuals aged ≥ 20 years ($n = 487$) from disadvantaged suburbs of Brisbane city, Australia, 2009

	Food secure (%)	Food insecure (%)	Food insecure (reference: food secure)	
			OR	95% CI
Dietary factors				
Fruit intake				
1 piece per day or less	52.8	62.9	1.00	
2 pieces per day	28.9	25.0	0.73	0.44, 1.19
3+ pieces per day	18.4	12.1	0.55	0.29, 1.05
Vegetable intake†				
1 serving per day or less	31.0	28.1	1.00	
2 servings per day	30.1	22.0	0.75	0.40, 1.42
3+ servings per day	38.9	22.1	0.89	0.47, 1.59
Frequency of takeaway consumption				
Hamburgers‡				
Never/rarely	53.6	44.0	1.00	
Less than once per week	32.9	38.8	1.20	0.70, 2.08
1 or more times per week	8.4	12.9	2.54*	1.10, 5.85
Fried chicken§				
Never/rarely	55.7	41.6	1.00	
Less than once per week	33.1	43.4	1.50	0.85, 2.67
1 or more times per week	11.1	15.0	1.28	0.56, 2.97
Fried fish/seafood				
Never/rarely	50.0	45.0	1.00	
Less than once per week	38.6	42.3	1.22	0.77, 1.93
1+ times per week	11.4	12.6	1.22	0.61, 2.44
Potato chip intake 				
Never/rarely	32.9	30.1	1.00	
Less than once per week	46.0	42.5	0.99	0.59, 1.68
1+ times per week	21.1	27.4	1.38	0.77, 2.49
Chinese/Asian/Indian¶				
Never/rarely	44.9	49.1	1.00	
Less than once per week	42.9	43.5	0.99	0.57, 1.72
1+ times per week	12.2	7.4	0.60	0.22, 1.62
Pizza††				
Never/rarely	55.0	45.5	1.00	
Less than once per week	40.5	44.6	1.34	0.84, 2.45
1+ times per week	4.50	9.8	1.90	0.77, 4.65
Cakes/sweet buns/muffins/scones				
Never/rarely	41.8	33.6	1.00	
Less than once per week	31.7	37.9	1.49	0.91, 2.45
1+ times per week	21.6	24.1	1.39	0.79, 2.43
Pies/sausage rolls/pastries††				
Never/rarely	52.4	43.1	1.00	
Less than once per week	32.3	39.7	1.51	0.93, 2.45
1+ times per week	9.8	12.9	1.67	0.82, 3.42
Frequency of meat consumption				
Processed meat¶¶				
Never/less than once per week	59.1	56.5	1.00	
1+ times per week	40.9	43.5	0.49	0.17, 1.43
Red meat†††				
Never/less than once per week	12.6	17.2	1.00	
1+ times per week	87.4	82.8	0.78	0.38, 1.58
Chicken††††				
Never/less than once per week	17.1	18.1	1.00	
1+ times per week	82.9	81.9	1.24	0.65, 2.37
Fish				
Never/less than once per week	46.5	48.2	1.00	
1+ times per week	53.5	51.8	0.93	0.61, 1.43
Health outcomes				
General health§§				
Excellent/very good	49.4	27.8	1.00	
Good	37.8	45.2	1.42	0.74, 2.73
Fair/poor	12.8	27.0	3.25*	1.52, 6.96
Visits to GP in last 6 months†††				
0 times	49.4	27.8	1.00	
1–2 times	37.8	45.2	2.43*	1.36, 4.36
3+ times	12.8	27.0	3.33*	1.61, 6.87
≥ 1 hospitalisations in last 6 months‡‡	7.9	16.7	2.17*	1.14, 4.14

Table 3 Continued

	Food secure (%)	Food insecure (%)	Food insecure (reference: food secure)	
			OR	95% CI
Chronic disease				
Diabetes ^{§§}	7.2	7.0	0.87	0.37, 2.03
High blood pressure	17.3	19.1	1.11	0.63, 1.97
High cholesterol	18.3	20.7	1.24	0.72, 2.15
Hardened arteries	1.2	1.8	1.52	0.27, 8.40
Heart attack ^{§§}	0.9	1.8	1.67	0.26, 10.82
Overweight/obesity	23.1	27.8	1.28	0.80, 2.07
Depression ^{¶¶}				
Low	50.7	16.4	1.00	
Middle	32.0	40.5	2.44*	1.26, 4.70
High	15.3	40.5	5.77*	2.88, 11.54
BMI ^{†††}				
Normal weight	44.0	22.9	1.00	
Overweight	33.4	19.2	0.93	0.54, 1.60
Obese	22.6	29.0	1.31	0.76, 2.26

GP, general practitioner.

*Significant at $P < 0.05$.

†Adjusted for equivalised household income.

‡Adjusted for indigenous status.

§Adjusted for equivalised household income, indigenous status, household structure and education.

||Adjusted for family type.

¶Adjusted for equivalised household income and education.

††Adjusted for family type and indigenous status.

†††Adjusted for equivalised household income and indigenous status.

§§Adjusted for indigenous status.

|||Adjusted for education and family type.

¶¶Adjusted for equivalised household income, indigenous status and household structure.

†††Adjusted for education.

takeaway foods. Evidence from the USA and Canada suggests that food insecurity is associated with lower intakes of fruit and vegetables^(22,23,25) and lean meat⁽²³⁾. Only one other study has investigated the association between food insecurity and takeaway consumption⁽²²⁾. Similar to the current study, it found no association between food insecurity and consumption of takeaway items⁽²²⁾. Limited consumption or exclusion of lean meats, fruits and vegetables among food-insecure individuals may be due to the perception that these food groups are expensive^(45,48). Objective data collected on food prices suggest that these food groups, which are less energy-dense, are more expensive than satiating energy-dense foods, such as those high in sugars or fats^(46,47). Consequently, food-insecure households may be less likely to consume foods such as lean meats, fruits and vegetables, and more likely to have diets that comprise more energy-dense options^(45,48).

Among the general Australian population, fruit and vegetable intakes have been found to be low, with about 50% and 10% of Australian adults consuming the recommended servings of fruits and vegetables, respectively⁽⁶⁶⁾. Lower socio-economic groups are less likely to consume the recommended servings of fruits and vegetables⁽⁶⁷⁾. Our sample of adults comprised primarily participants who were disadvantaged in terms of their area- and individual-level socio-economic position. Compared with a population-representative sample, the fruit and vegetable intakes of the current sample were lower⁽⁶⁶⁾.

Therefore, an association between food insecurity and fruit and vegetable intakes may not have been apparent, as has been shown in studies utilising samples with greater socio-economic variation^(21,22,24).

The findings of the current study did not support an association between food insecurity and weight status. Evidence from previous studies is inconsistent and the existence of an association between food insecurity and weight status remains debatable; some studies have shown a positive association (more consistently seen among women)^(21,38-44), whereas others report no association^(30,68-71). Socio-economic disadvantage, particularly among women, has been shown to be associated with overweight and obesity⁽⁷²⁾. The null association found in the current study may be due to the sample being drawn from socio-economically disadvantaged areas. Our reliance on self-reported height and weight to calculate BMI may also explain the lack of an association, as individuals are more likely to overestimate their height and underestimate their weight⁽⁷³⁻⁷⁶⁾, resulting in a lower calculated BMI.

We did not find any association between food insecurity and self-reported diabetes, high cholesterol, hardened arteries or stroke. Similarly, this lack of association may be due to our socio-economically disadvantaged sample. There is a limited body of literature pertaining to associations between food insecurity and chronic disease, specifically heart disease, blood pressure, cholesterol and diabetes. Heart disease and high blood pressure have previously

been shown to be associated with food insecurity in one Canadian study⁽²⁰⁾; however, these results were not replicated among other studies in the USA^(30,32). Multiple studies have suggested that food insecurity is positively associated with diabetes^(8,20,43). The evidence pertaining to cholesterol is inconsistent. One study found that food insecurity was associated with raised levels of LDL cholesterol and TAG among American women⁽³¹⁾; however, two other studies contradicted these findings^(30,32).

The findings of the current study should be interpreted within the context of a number of limitations. First, the cross-sectional nature of the study did not allow for assessment of the temporal relationship between food insecurity and potential outcomes; consequently it is unknown whether food insecurity preceded the development of poor health, depression and increased health-service utilisation or whether food insecurity occurred as a result of these conditions. Second, our data were collected via mail survey, which may have biased the sample against those from non-English speaking backgrounds and/or with poor literacy. Consequently, our study may under-represent some of the most disadvantaged segments of society and those at highest risk of experiencing food insecurity; therefore the magnitude of associations in the current study may underestimate those in the population. Third, our survey relied on self-reported data, leaving our study open to potential response bias. In particular, participants may have under-reported with regard to weight status^(73–76). Potential under-reporting of food insecurity may suggest a rate higher than the 25% identified in our study.

There are very few studies investigating the associations between food insecurity, health status, health-care utilisation, chronic conditions and dietary behaviours. More research is required, particularly among developed countries outside the USA, to monitor the prevalence and potential consequences of food insecurity. The findings of the current study may provide a framework for the development or improvement of policies and interventions to address factors associated with food insecurity in an effort to reduce the potential social and economic burdens.

Conclusions

Food insecurity may be prevalent in urbanised disadvantaged areas in Australia; among this sample, approximately 25% of respondents reported household food insecurity. Households with lower incomes may be at higher risk of experiencing food insecurity. Furthermore, individuals experiencing food insecurity may be at risk of a wide range of adverse health outcomes, including poorer general health and increased risk of depression, and are likely to increase their utilisation of general practitioner and hospital services. As the prevalence of food insecurity is predicted to increase in the context of the recent food

and financial crises, the public health significance of food insecurity is likely to increase.

Acknowledgements

This work was supported by a Queensland University of Technology Research Grants Scheme. R.R. was supported by an Australian Postgraduate Award Scholarship and G.T. was supported by a National Health and Medical Research Council Research Fellowship. There were no conflicts of interest. R.R. conceptualised and wrote the paper, and has primary responsibility for the final content. K.G., G.T. and D.G. assisted in conceptualisation of the review, provided input into writing of the manuscript and feedback on subsequent drafts. All authors have read and approved the final manuscript.

References

1. Food and Agriculture Organization of the United Nations (2005) *Voluntary Guidelines to Support the Progressive Realization of the Right to Adequate Food in the Context of National Food Security*. Rome: FAO.
2. Food and Agriculture Organization of the United Nations (2003) *Trade Reforms and Food Security: Conceptualizing the Linkages*. Rome: FAO.
3. Kendall A & Kennedy E (1998) Position of the American Dietetic Association: domestic food and nutrition security. *J Am Diet Assoc* **98**, 337–342.
4. Gundersen C & Gruber J (1999) The dynamic determinants of food insufficiency. In *Second Food Security Measurement and Research Conference*, pp. 91–109 (M Andrews and M Prell, editors). Alexandria, VA: US Department of Agriculture.
5. Hamelin AM, Beaudry M & Habicht JP (2002) Characterization of household food insecurity in Quebec: food and feelings. *Soc Sci Med* **54**, 119–132.
6. Phillips T & Taylor D (1990) Optimal control of food insecurity: a conceptual framework. *Am J Agric Econ* **72**, 1304–1310.
7. Booth S & Smith A (2001) Food security and poverty in Australia – challenges for dietitians. *Aust J Nutr Diet* **58**, 150–156.
8. Holben DH (2006) Position of the American Dietetic Association: food insecurity and hunger in the United States. *J Am Diet Assoc* **106**, 446–458.
9. Alaimo K, Briefel RR, Frongillo E *et al.* (1998) Food insufficiency exists in the United States: results from the Third National Health and Nutrition Examination Survey (NHANES III). *Am J Public Health* **88**, 419–426.
10. Bartfield J & Dunifon R (2006) State-level predictors of food insecurity among households with children. *J Policy Anal Manage* **25**, 921–942.
11. Bernell S, Weber B & Edwards M (2006) Restricted opportunities, personal choices, ineffective policies: what explains food insecurity in Oregon? *J Agric Res Econ* **31**, 193–211.
12. Chavez N, Telleen S, Ok Y *et al.* (2007) Food insufficiency in urban Latino families. *J Immigr Minor Health* **9**, 197–204.
13. Stuff JE, Horton JA, Bogle ML *et al.* (2004) High prevalence of food insecurity and hunger in households in the rural Lower Mississippi Delta. *J Rural Health* **20**, 173–180.
14. McIntyre L, Connor SK & Warren J (2000) Child hunger in Canada: results of the 1994 National Longitudinal Survey of Children and Youth. *CMAJ* **163**, 961–965.

15. Cutler-Triggs C, Fryer G, Miyoshi T *et al.* (2008) Increased rates and severity of child and adult food insecurity in households with adult smokers. *Arch Pediatr Adolesc Med* **162**, 1056–1062.
16. Kaiser L, Baumrind N & Dumbauld S (2007) Who is food-insecure in California? Findings from the California Women's Health Survey. *Public Health Nutr* **10**, 574–581.
17. Kersey M, Geppert J & Cutts D (2007) Hunger in young children of Mexican immigrant families. *Public Health Nutr* **10**, 390–395.
18. Willows N, Veugelers P, Raine K *et al.* (2009) Prevalence and sociodemographic risk factors related to household food security in Aboriginal peoples in Canada. *Public Health Nutr* **12**, 1150–1156.
19. De Marco M & Thornburn S (2008) The association between sociodemographic factors, participation in assistance programs, and food insecurity among Oregon residents. *J Hunger Environ Nutr* **3**, 36–50.
20. Vozoris NT & Tarasuk VS (2003) Household food insufficiency is associated with poorer health. *J Nutr* **133**, 120–126.
21. Radimer KL, Allsopp R, Harvey PW *et al.* (1997) Food insufficiency in Queensland. *Aust N Z J Public Health* **21**, 303–310.
22. Tingay RS, Tan CJ, Tan NCW *et al.* (2003) Food insecurity and low income in an English inner city. *J Public Health Med* **25**, 156–159.
23. Tarasuk VS (2001) Household food insecurity with hunger is associated with women's food intakes, health and household circumstances. *J Nutr* **131**, 2670–2676.
24. Kirkpatrick SI & Tarasuk V (2008) Food insecurity is associated with nutrient inadequacies among Canadian adults and adolescents. *J Nutr* **138**, 604–612.
25. Kaiser LL, Melgar-Quionez H, Townsend MS *et al.* (2003) Food insecurity and food supplies in Latino households with young children. *J Nutr Educ Behav* **35**, 148–153.
26. Siefert K, Heflin CM, Corcoran ME *et al.* (2001) Food insufficiency and the physical and mental health of low-income women. *Women Health* **32**, 159–177.
27. Siefert K, Heflin CM, Corcoran ME *et al.* (2004) Food insufficiency and physical and mental health in a longitudinal survey of welfare recipients. *J Health Soc Behav* **45**, 171–186.
28. Pheley AM, Holben DH, Graham AS *et al.* (2002) Food security and perceptions of health status: a preliminary study in rural Appalachia. *J Rural Health* **18**, 447–454.
29. Walker JL, Holben DH, Kropf ML *et al.* (2007) Household food insecurity is inversely associated with social capital and health in females from special supplemental nutrition program for women, infants, and children households in Appalachian Ohio. *J Am Diet Assoc* **107**, 1989–1993.
30. Weigel M, Armijos R, Posada Hall Y *et al.* (2007) The household food insecurity and health outcomes of US–Mexico border migrant and seasonal farmworkers. *J Immigr Minor Health* **9**, 157–169.
31. Tayie FA & Zizza CA (2009) Food insecurity and dyslipidemia among adults in the United States. *Prev Med* **48**, 480–485.
32. Holben DH & Pheley AM (2006) Diabetes risk and obesity in food-insecure households in rural Appalachian Ohio. *Prev Chronic Dis* **3**, A82.
33. Laraia BA, Siega-Riz AM, Gundersen C *et al.* (2006) Psychosocial factors and socioeconomic indicators are associated with household food insecurity among pregnant women. *J Nutr* **136**, 177–182.
34. Casey P, Goolsby S, Berkowitz C *et al.* (2004) Maternal depression, changing public assistance, food security and child health status. *Pediatrics* **113**, 298–304.
35. Heflin CM, Siefert K & Williams DR (2005) Food insufficiency and women's mental health: findings from a 3-year panel of welfare recipients. *Soc Sci Med* **61**, 1971–1982.
36. Whitaker RC, Phillips SM & Orzol SM (2006) Food insecurity and the risks of depression and anxiety in mothers and behavior problems in their preschool-aged children. *Pediatrics* **118**, e859–e868.
37. Fuller-Thomson E & Nimigon J (2008) Factors associated with depression among individuals with chronic fatigue syndrome: findings from a nationally representative survey. *Fam Pract* **25**, 414–422.
38. Wilde PE & Peterman JN (2006) Individual weight change is associated with household food security status. *J Nutr* **136**, 1395–1400.
39. Adams EJ, Grummer-Strawn L & Chavez G (2003) Food insecurity is associated with increased risk of obesity in California women. *J Nutr* **133**, 1070–1074.
40. Tayie FA & Zizza CA (2009) Height differences and the associations between food insecurity, percentage body fat and BMI among men and women. *Public Health Nutr* **12**, 1855–1861.
41. Bhattacharya J, Currie J & Haider S (2004) Poverty, food insecurity, and nutritional outcomes in children and adults. *J Health Econ* **23**, 839–862.
42. Hanson K, Sobal J & Frongillo E (2007) Gender and marital status clarify associations between food insecurity and body weight. *J Nutr* **137**, 1460–1465.
43. Seligman HK, Bindman AB, Vittinghoff E *et al.* (2007) Food insecurity is associated with diabetes mellitus: results from the National Health Examination and Nutrition Examination Survey (NHANES) 1999–2002. *J Gen Intern Med* **22**, 1018–1023.
44. Townsend MS, Peerson J, Love B *et al.* (2001) Food insecurity is positively related to overweight in women. *J Nutr* **131**, 1738–1745.
45. Scheier LM (2005) What is the hunger–obesity paradox? *J Am Diet Assoc* **105**, 883–886.
46. Drewnowski A (2004) Obesity and the food environment: dietary energy density and diet costs. *Am J Prev Med* **27**, 3 Suppl., 154–162.
47. Drewnowski A & Specter S (2004) Poverty and obesity: the role of energy density and energy costs. *Am J Clin Nutr* **79**, 6–16.
48. Tanumihardo SA, Anderson C, Kaufer-Horwitz M *et al.* (2007) Poverty, obesity, and malnutrition: an international perspective recognizing the paradox. *J Am Diet Assoc* **107**, 1966–1972.
49. Wilkinson R (1997) Socioeconomic determinants of health: health inequalities: relative or absolute material standards? *BMJ* **314**, 591–595.
50. Nolan M, Rikard-Bell G, Mohsin M *et al.* (2006) Food insecurity in three socially disadvantaged localities in Sydney. *Health Promot J Aust* **17**, 247–254.
51. Quine S & Morrell S (2006) Food insecurity in community-dwelling older Australians. *Public Health Nutr* **9**, 219–224.
52. Temple JB (2006) Food insecurity among older Australians: prevalence, correlates and well-being. *Australas J Ageing* **25**, 158–163.
53. International Monetary Fund (2010) Hunger on the rise. *Finance & Development* **47**, issue 1; available at <http://www.imf.org/external/pubs/ft/fandd/2010/03/picture.htm>
54. Food and Agriculture Organization of the United Nations (2009) *The State of Food Insecurity in the World: Economic Crises – Impacts and Lessons Learned*. Rome: FAO.
55. Keenan DP, Olson C, Hersey JC *et al.* (2001) Measures of food insecurity/security. *J Nutr Educ* **33**, Suppl. 1, S49–S58.
56. Prochaska J (2008) Multiple health behaviour research represents the future of preventative medicine. *Prev Med* **46**, 281–285.
57. Glanz K, Lewis F & Rimer B (1997) *Health Behaviour and Health Education: Theory, Research and Practice*. San Francisco, CA: Jossey-Bass.
58. Australian Bureau of Statistics (2008) *2039.0 – Information Paper: An Introduction to Socio-Economic Indexes for Areas (SEIFA), 2006*. Canberra: ABS.

59. Dillman D (1999) The design and administration of mail surveys. *Ann Rev Sociol* **17**, 225–249.
60. Australian Bureau of Statistics (2004–2005) *National Health Survey Users' Guide*. Canberra: ABS.
61. Cancer Council Queensland (2005) *Queensland Cancer Risk Study*. Brisbane: Cancer Council Queensland.
62. Australian Bureau of Statistics (1995) *National Nutrition Survey Users' Guide*. Canberra: ABS.
63. World Health Organization (2010) Global Database on Body Mass Index – BMI classification. http://apps.who.int/bmi/index.jsp?introPage=intro_3.html
64. Kushel MB, Gupta R, Gee L *et al.* (2005) Housing instability and food insecurity as barriers to health care among low-income Americans. *J Gen Intern Med* **21**, 71–77.
65. Nelson K, Cunningham W, Anderson R *et al.* (2001) Is food insufficiency associated with health status and health care utilization among adults with diabetes? *J Gen Intern Med* **16**, 404–411.
66. Australian Bureau of Statistics (2009) *4364.0 – National Health Survey: Summary of Results, 2007–2008 (Reissue)*. Canberra: ABS.
67. Giskes K, Turrell G, Patterson C *et al.* (2002) Socio-economic differences in fruit and vegetable consumption among Australian adolescents and adults. *Public Health Nutr* **5**, 663–669.
68. Jones SJ & Frongillo EA (2007) Food insecurity and subsequent weight gain in women. *Public Health Nutr* **10**, 145–151.
69. Laraia BA, Siega-Riz AM & Evenson KR (2004) Self-reported overweight and obesity are not associated with concern about enough food among adults in New York and Louisiana. *Prev Med* **38**, 175–181.
70. Webb AL, Schiff A, Currihan D *et al.* (2008) Food Stamp Program participation but not food insecurity is associated with higher adult BMI in Massachusetts residents living in low-income neighbourhoods. *Public Health Nutr* **11**, 1245–1255.
71. Whitaker RC & Sarin A (2007) Change in food security status and change in weight are not associated in urban women with preschool children. *J Nutr* **137**, 2134–2139.
72. McLaren L (2007) Socioeconomic status and obesity. *Epidemiol Rev* **29**, 29–48.
73. Nyholm M, Gullberg B, Merlo J *et al.* (2007) The validity of obesity based on self-reported weight and height: implications for population studies. *Obesity (Silver Spring)* **15**, 197–206.
74. Engstrom JL, Paterson S, Doherty A *et al.* (2003) Accuracy of self-reported height and weight in women: an integrative review of the literature. *J Midwifery Womens Health* **48**, 338–345.
75. Spencer EA, Appleby PN, Davey GK *et al.* (2002) Validity of self-reported height and weight in 4808 EPIC–Oxford participants. *Public Health Nutr* **5**, 561–565.
76. Stewart AW, Jackson RT, Ford MA *et al.* (1987) Underestimation of relative weight by use of self-reported height and weight. *Am J Epidemiol* **125**, 122–126.