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Food insecurity and poor diet quality are associated with reduced quality of life in older adults

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Abstract

Aim: The aim of this study was to examine the relationships of food security and diet quality with health related quality of life (HRQoL) in a cohort of older Australians. Methods: Data were collected as part of the Blue Mountains Eye Study, a cohort study of community-living individuals aged 49 years and over. A 12-item food security survey, the Short-form 36-item (SF-36) health survey, assessing four physical and four mental domains of HRQoL, and a food frequency questionnaire (FFQ) were completed by 2642 participants. The Total Diet Score (TDS) (maximum score 20) measured diet quality based on food intake from the FFQ. Analysis of covariance compared adjusted mean differences in SF-36 scores between (i) food secure and food insecure groups and (ii) quartiles of TDS. Higher SF-36 scores indicated better physical and mental health. Results: Across all SF-36, domains scores were significantly lower in the food insecure group compared to the food secure group. Adjusted mean differences ranged from 4.01 (95% confidence intervals (CIs): 1.64, 6.38) to 18.00 (95% CIs: 13.43, 22.56). Individuals in the lowest quartile of TDS had significantly lower SF-36 scores compared to those in the highest TDS quartile for physical functioning domain (4.46, 95% CIs: 1.67, 7.26) and vitality domain (4.14, 95% CIs: 1.34, 6.95). Conclusions: The study findings provide evidence of associations between reduced physical and mental health and food insecurity and poor diet quality, respectively. Further research into food insecurity in the ageing population is required to ensure that good health is maintained through appropriate health and community services.

Keywords

poor, diet, food, quality, insecurity, associated, reduced, life, older, adults

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Food insecurity and poor diet quality are associated with reduced quality of life in older adults

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ABSTRACT

Aim: The aim of this study was to examine the relationships of food security and diet quality with health related quality of life (HRQoL) in a cohort of older Australians.

Methods: Data were collected as part of the Blue Mountains Eye Study, a cohort study of community living individuals aged 49 years and over. A 12-item food security survey, the SF-36 health survey, assessing four physical and four mental domains of HRQoL, and food frequency questionnaire were completed by 2642 participants. The Total Diet Score (TDS) (maximum score 20) measured diet quality based on food intake from the FFQ. Analysis of covariance compared adjusted mean differences in SF-36 scores between a) food secure and food insecure groups and; b) quartiles of TDS. Higher SF-36 scores indicated better physical and mental health.

Results: Across all SF-36 domains scores were significantly lower in the food insecure group compared to the food secure group. Adjusted mean differences ranged from 4.01 (95% CIs: 1.64, 6.38) to 18.00 (95% CIs: 13.43, 22.56). Individuals in the lowest quartile of TDS had significantly lower SF-36 scores compared to those in the highest TDS quartile for physical functioning domain (4.46, 95% CIs: 1.67, 7.26) and vitality domain (4.14 (95% CIs: 1.34, 6.95).

Conclusions: The study findings provide evidence of associations between reduced physical and mental health and food insecurity and poor diet quality respectively. Further research into food insecurity in the ageing population is required to ensure good health is maintained through appropriate health and community services.

Keywords: Food security, diet quality, health related quality of life, older adults

INTRODUCTION

The older adult population is rapidly growing and an increasing number of individuals in this age group are at risk of developing a chronic disease and/or physical limitations.[1] More than half of Australian older adults report having five or more long term conditions.[2] Assessing health related quality of life (HRQoL) encompassing physical and mental health as well as social and emotional wellbeing is potentially a better indicator of health status than morbidity in older adults.[3] Previous studies have found self-reported HRQoL to be a good predictor of mortality.[4-6]

Research into HRQoL and food insecurity in older adults is limited. Food insecurity is defined as either limited availability of nutritious foods and/or the inability to acquire nutritionally acceptable and safe foods.[7] From analysis of a single question from the National Health and Nutrition Examination Survey, food insufficient older adults were 2.33 times more likely than those identified as food sufficient to report poor/fair self-reported health after adjusting for potential confounders including age, gender, race, Poverty Index Ratio, education, living arrangement, food program participation, functional impairment, presence of at least one chronic disease, changes in dietary habits due to health problems, dietary supplement use and medication use.[1] Significantly lower intakes of energy, protein, carbohydrate, and seven micronutrients were also reported in this study. In addition, Rose & Oliveira[8] found that older adults who were food insufficient had lower intakes of eight nutrients including energy and calcium. Evidence assessing overall diet and food insecurity found food secure adults had higher diet quality scores than food insecure adults.[9]

The association between diet quality and food security is debateable and there is again limited research in Australia. The nature of food security encompasses both the availability of and

access to food and could have a role in determining an individual's diet quality. Radimer[10] found that eating meat less than once a week, having lower fruit and vegetable intakes and more frequent consumption of takeaway foods was significantly associated with food insufficiency in Queensland adults.

Investigation into the relationship between diet quality, measured as overall diet, and health suggests the risk of mortality and the risk of developing chronic disease is reduced with higher diet quality.[11] Research has also shown that poorer HRQoL was related to poorer diet quality but the focus to date has been limited to patients with chronic diseases or younger age groups.[12, 13] Findings from a cross sectional study in Spain suggested that better mental and physical quality of life was associated with greater adherence to the Mediterranean Diet, a diet characterised by high intakes of fruit, vegetables, legumes and fish with moderate consumption of alcohol, in both men and women aged between 35 and 74 years.[14] Similarly, Henrique-Sanchez[15] found that university graduates with high diet quality scores at baseline had better physical functioning, general health and vitality after four-year follow up.

This study examines the individual relationships between a) food security status and b) diet quality, expressed as adherence to published dietary guidelines, and HRQoL, in a cohort of community living older Australians. HRQoL was measured using the 36-item Short-Form Health Survey (SF-36).

METHODS

Study

The Blue Mountains Eye Study (BMES) is a population based cohort study of vision and common eye diseases in residents west of Sydney aged 49 years and over. Full details of the

study design have previously been reported.[16] In 1992-1994 (BMES1), 3,654 participants attended in baseline examinations. After five years, all participants from BMES1 were invited to attend repeat examinations and 2,335 (75.1%) survivors were examined (BMES2A). In 1999, a further 1,174 (85.2%) participants were recruited from 1,378 eligible residents who had either moved into the study area or reached the minimum age criteria (BMES2B). Cross Section 2 is made up of a combination of BMES2A and BMES2B, with a total of 3,508 participants examined.

The study followed the recommendations of the Declaration of Helsinki and was approved by Sydney West Area Health Service and University of Sydney Human Research Ethics Committees. Written informed consent was provided by all participants.

Data collection

Prior to clinic examinations, a detailed questionnaire including the SF-36, food frequency questionnaire (FFQ) and food security survey was mailed to all participants of Cross Section 2. Participants provided information about socio-demographic factors and their medical history during face-to-face interviews conducted as part of the clinic visits. Age, gender, marital status and level of education attained were also recorded and participants were asked whether they received a government pension or not. A history of Acute Myocardial Infarction (AMI), stroke, arthritis, asthma and cancer if previously diagnosed by their doctor was self-reported; self-rated health was reported as excellent, good, fair or poor. Hypertension was defined if participants recorded a systolic blood pressure ≥160mmHg or diastolic blood pressure ≥100mmHg at the clinic visit or were using antihypertensive medication. Body Mass Index (BMI) was calculated from measured height and weight

75 (kg/m^2). Walking disability was assessed by examiners during clinic visits as any subject who
76 had walking difficulties or used a cane/crutches/walker or a wheel chair.
77
78 **Health Related Quality of Life**
79 HRQoL was assessed using the Short Form 36 questionnaire (SF-36), a commonly used self-
80 reported health survey.[17] This questionnaire includes 36 items that provide information on
81 eight domains of physical and mental health and wellbeing. These include physical
82 functioning, role limitations due to physical problems, bodily pain, general health
83 perceptions, vitality, social functioning, role limitations due to emotional problems and
84 mental health. The eight subscales were then summarized into two component scores, with
85 the first four domains represented as a physical component score and the latter four domains
86 represented as a mental component score. Higher scores in all domains and components
87 reflect better health with a range from 0-100.[17] The SF-36 has been validated in this cohort
88 and found to be an effective measure of health in older community based populations.[18]
89
90 **Food Security Survey**
91 The food security survey was adapted from the Radimer/Cornell measures of hunger and
92 food insecurity[19] and comprised 12 statements relating to individual and household food
93 situations (See Appendix I). The statements address different aspects of food insecurity
94 including concern about running out of food, reduced quality and decreased quantity of food
95 consumed. Details of the food security survey have been published previously.[20]
96
97 For this analysis and consistent with the literature,[10] participants were coded as food secure if
98 they answered "never true" to all 12 statements and food insecure if they answered any one of

99 the statements “sometimes true” or “often true” to determine all individuals who were food
100 insecure irrespective of the degree of food insecurity.
101
102 **Total Diet Score**
103 Diet quality scores were calculated from a 145 item semi-quantitative food frequency
104 questionnaire adapted to the Australian diet and vernacular from a Willett FFQ.[21] Details of
105 the Total Diet Score (TDS) have been published previously.[11] Briefly, the TDS was
106 developed to assess diet quality in terms of adherence to the Dietary Guidelines for
107 Australian Adults (DGAA).[22] The TDS was made up of ten components, and each component
108 had a maximum score of 2 for those who met the dietary guidelines recommendations, with
109 prorated scores between 0 and 2 for lower intakes. The component scores were summed to
110 provide an overall score that ranged between 0 and 20. The TDS measured both food intake
111 of the five core food groups and intake of optimal choice foods that have greater dietary
112 benefits, as recommended in the Australian Guide to Health Eating (AGHE).[23] To allow for
113 FFQ overestimation of fruit and vegetable intake in this cohort, as determined by the validity
114 study,[21] we replaced the AGHE’s recommended two serves per day of fruit with three serves
115 per day and the number of vegetables consumed per day increased from five serves to seven
116 serves.
117
118 **Statistical Analysis**
119 The eight SF-36 domains and two SF-36 component scores were the dependent variables
120 with food security status (yes/no) and TDS scores (quartiles) selected as the respective
121 independent variables. SF-36 scores for each of the eight domains were coded, summated and
122 transformed according to the SF-36 manual.[17] The physical and component scores were
123 calculated using factor analysis and the Australian population normalised scores.[18, 24]

The mean SF-36 physical and mental component scores were compared across a range of the participants' socio-demographic and health factors. Differences in mean SF-36 scores between groups were assessed by t-tests for two groups and ANOVA *f* tests for multiple groups. Tests for linear trend across quartiles of TDS were calculated by using the median of each TDS quartile as a continuous variable.

A stepwise regression model was developed to determine the subset of variables that significantly affected either the physical or mental health component scores. The final model included age group, smoking status, marital status, income source, BMI, hypertension, walking disability, angina, arthritis, having two or more disabilities and self-rated health (co-independent variables). Interactions were tested for selected variables and food security status; only self-rated health remained significant as an interaction variable and was included in the final model.

To determine whether food insecurity was independent of diet quality, interaction terms were calculated for all domains and components of the SF-36. No significant interactions were found, implying the relationship between HRQoL and food insecurity was not mediated by diet quality (data not shown). Therefore, adjusted mean SF-36 scores were calculated separately for both food security and the Total Diet Score, with the TDS included as a covariate in the food security final model and food security included as a covariate in the TDS final model.

Multivariate analysis of covariance (MANCOVA) was used to compare the differences of the eight SF-36 domains and food security status. Differences for the two component scores, physical and mental health were compared in a separate MANCOVA. The two MANCOVAs were repeated to compare the difference in scores of the SF-36 domains and components and quartiles of TDS. Statistical significance of the independent variable was assessed as Wilks Lambda $p < 0.05$. The MANCOVA results were significant for each SF-36 domain and component score for both independent variables. Therefore each SF-36 domain and component score was analysed by a separate ANCOVA to determine adjusted mean differences between food security status and quartiles of TDS respectively.

Post hoc analyses of the TDS were adjusted for Tukey's test for multiple comparisons to determine SF-36 adjusted mean differences between the TDS quartiles.

To establish whether the group differences were meaningful, the effect size was calculated by taking the difference between the SF-36 scores and dividing by the Standard Deviation of the complete sample (Mean X_1 – Mean X_2)/SD.[25] For this study, the root mean square error (RMSE) was used as the standard deviation from each individual ANCOVA SF-36 domain or component analysis.

All statistical analyses were performed using SAS (version 9.2; SAS Institute, Cary, NC, USA).

RESULTS

Only those participants with complete data for food security, diet quality and HRQoL were included in the final analysis (n=2642, 75.3% of participants examined in the BMES Cross

Section 2). In this cohort, the mean physical component score (45.2) was lower than the Australian norms (Mean 50, SD 10) as would be expected in an older age group whilst the mental component score was similar to the Australian norms (Table 1).

Mean SF-36 physical and mental component scores were compared across a range of socio demographic and health factors and the results are shown in Table 1. Participants who were of older age, widowed, renting a home, a high school education, living on a pension only or had a BMI ≥30 had significantly lower SF-36 physical component scores. Significantly lower mental component scores were found in younger aged participants and smokers. The greatest differences for the physical component scores were seen for the health factors when fair/poor self-rated health was compared to excellent/good self-rated health (34.97 vs 47.59) and individuals classified with a walking disability compared to those without a walking disability (29.68 vs 46.23). For the mental component scores, the most notable difference was for self-rated health (Fair/poor 46.16 vs Excellent/good 53.32).

HRQol and Food security status

Figure 1 clearly shows the mean SF-36 score differences by food security status for each SF-36 domain. Study participants who reported being food secure followed a similar HRQoL pattern to the SF-36 normalized Australian scores for age group 45 years and over.[24] However two SF-36 domains, role limitations due to physical problems and role limitations due to mental problems, had notably greater differences to the food secure group than the other domains.

The adjusted mean scores and differences between the food secure group and food insecure group for all SF-36 domains scores are given in Table 3. Participants who reported some level of food insecurity had significantly lower HRQoL scores across all eight SF-36 domains (Table 2). The differences in effect size between the food secure group and food insecure group for the SF-36 eight domains ranged from 0.24 to 0.57 (Table 2) suggesting some potentially meaningful differences between the groups based in Cohen's guidelines for interpreting effect sizes.[25, 26] Similarly, mean scores were significantly lower in both the physical component score and mental component score for the food insecure group compared to the food secure group (41.74 vs 45.66 and 47.03 vs 52.66 respectively).

HRQol and diet quality

A trend for increasing SF-36 scores with increasing TDS quartile (lowest to highest diet quality) was found for five SF-36 domains; physical functioning, general health, vitality, role limitations due to mental problems, mental health as well as the mental component score (Table 3). Although there was a significant trend for increasing mental and physical health with increasing diet quality, the differences between quartiles were small as confirmed by the small effect sizes (range 0.02 to 0.25).

HRQoL, food security and diet quality

Although there was no significant association between food security status and diet quality score. Significantly lower SF-36 mental component scores but not physical component scores were found in the food insecure group when stratified across the quartiles of TDS (Table 4). In addition, all mental component scores for the food insecure group were below the Australian norms.

DISCUSSION

In this cohort of older adults, being food insecure and having poorer diet quality were associated with reduced HRQoL after adjusting for a range of socio-demographic and health factors.

In Australia to date, the evidence of food insecurity has been based on a single item assessing the ability to afford food. Temple[27] reported that food insecure Australians aged 55 and over were more likely to report feeling terrible, unhappy or dissatisfied with their lives. Findings from The Older Person's Health Survey in New South Wales, Australia also found that both men and women who reported running out of food were significantly more likely to report poor self-rated health than excellent self-rated health.[28] Our study provides further substantive evidence of a relationship between food insecurity and poorer self-rated health status in older Australians.

Our results are based on data collected from a more comprehensive tool that examines the broader context of food security covering psychological and qualitative aspects relating to food intake as well as the ability to afford food. Using this tool we found a higher proportion of older adults with some level of food insecurity (12%) than has previously been reported in Australia using the single question (4%).[29] However, the findings in this study are consistent with previous studies conducted in North America using a similar tool that found declining physical and mental health was associated with worsening food insecurity status.[1, 30-33]

In our cohort, food insecure participants had lower scores (indicating poorer health) across the eight SF-36 domains when compared to the corresponding age SF-36 Australian norms.[24] An explanation for the greater differences between the two SF-36 role limitation domains

247 (physical and emotional) could be they are more applicable to older adults. These two
248 domains assess problems with daily activities due to physical health and emotional problems
249 respectively.[17] Poor physical functioning may be an important limitation on older people's
250 ability to acquire or prepare appropriate foods. Carrying, bending and shortness of breath
251 have previously been suggested as physical reasons for shopping difficulties.[34] In addition,
252 UK older adults participating in focus groups reported that accessibility, such as difficulty in
253 walking long distances and being unable to carry heavy shopping bags, was more important
254 than the cost of the food.[35] Burns et al[36] also reported that older adults were more likely to
255 have difficulty lifting or carrying groceries compared to younger adults who were more likely
256 to report lack of money to buy food as impacting on accessibility.
257
258 In this study no significant relationship was found between food security status and diet
259 quality, and the relationship between food security and HRQoL was independent of diet
260 quality. One other study also reported no significant relationship between food insecurity and
261 the Healthy Eating Index (HEI). The authors reported lower HEI scores for individual
262 components in food insecure adults aged over 18 years.[9] However, previous research has
263 shown that food insufficient older adults had lower nutrient intakes[11] and that being food
264 insecure could lead to malnutrition both in terms of under and over nutrition. Our findings
265 add to the debate as to whether food security status is a predictor or outcome of poor health
266 and diet quality. Further research looking at the relationship between food security, diet
267 quality and HRQoL over time would provide a clearer understanding of the pathways.
268
269 Effect sizes were also calculated for diet quality but the results were low and classified as
270 potentially meaningless, providing no evidence of an effect of diet quality on HRQoL after
271 multivariate adjustment. Two domains of HRQoL had significantly higher scores for those

272 with the highest diet quality scores compared to those with the lowest diet quality scores.
273 This is consistent with previous findings that closer adherence to the Mediterranean diet was
274 associated with better mental and physical health.[14] Results from the SUN project in a group
275 of university graduates suggested that adhering to the Mediterranean diet over a four year
276 follow up was associated with both physical and mental health and more strongly for the
277 former.[15] Similar to our findings, significant differences between highest and lowest diet
278 quality scores were only significant for physical functioning, general health and vitality.
279
280 The strengths of this study include a large population based sample with a high response rate,
281 as well as detailed data collection, which enhanced the multivariate analysis. In addition, use
282 of the adapted Radimer/Cornell 12-item tool provided more detailed information about food
283 insecurity within an older Australian population than currently available in other Australian
284 datasets. Our findings highlight the importance of using a range of questions to determine
285 food insecurity status. However, the questions asked continue to be based on economic
286 resources to acquire food. Our findings suggest that specific characteristics of food
287 insecurity associated with older adults, such as physical limitations (mobility) and increasing
288 number of chronic diseases, should be incorporated in a food insecurity tool for older
289 populations.
290
291 One limitation of the study was the exclusion of those who had incomplete data on diet
292 quality or food security. We examined the differences in those with and without data and
293 found that those with missing data could potentially be at greater risk of food insecurity, as
294 there was a higher proportion of smokers, people living alone, living on a pension, widowed,
295 classified as obese, having a walking disability, as well as people with poorer health. These
296 factors have previously been found to be associated with food insecurity in this cohort.[11] In

these circumstances, it could be suggested that the relationship between both food insecurity and poor diet quality and reduced HRQoL may be greater than reported here.

This study was a cross-sectional analysis of a cohort of older Australians; therefore it was not possible to determine causal pathways between food insecurity and/or diet quality and HRQoL. Indeed the reverse may also be true, in that older adults with poorer HRQoL are more likely to become food insecure or have poorer dietary intakes, as hypothesised by Campbell.[37]

CONCLUSION

The significant association between food insecurity and reduced HRQoL found in this study provides further evidence that food insecurity is an important risk factor in older adults. The findings from this study provide some of the first insights into the relationship between perceived health status with both food security and diet quality, highlighting the need for further research into this area.

In addition, the findings of this study suggest that services with an aim to reduce food insecurity are required to reduce the risk of physical health decline and to improve mental and social support for this age group. If food insecurity can be reduced in this population, it also may potentially play a role in improving diet quality. However, additional research into how different elements of food insecurity affect diet quality in older Australians is also required, particularly as many of this older population suffer from reduced mobility or functional limitations.

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Table 1. SF-36 mental and physical component scores across sociodemographic and health factors

Subgroup	Physical Component Score Mean (SD)	*P* value*	Mental Component Score Mean (SD)	*P* value*
All n = 2636	45.2 (10.9)		52.0 (9.9)	
Age				
49 - 59 years	48.6 (10.1)		50.5 (10.4)	
60 - 69 years	46.4 (10.1)		52.7 (9.5)	
70 - 79 years	42.3 (11.0)		52.4 (9.5)	
80+ years	38.0 (11.2)	<.0001	52.0 (10.8)	<.0001
Gender				
Female	44.4 (11.3)		51.9 (10.0)	
Male	46.2 (10.4)	<.0001	52.0 (9.8)	0.8239
Smoking Status				
Non smoker	45.2 (10.9)		52.2 (9.8)	
Current Smoker	44.8 (11.5)	0.5407	49.9 (10.8)	0.001
Marital Status				
Currently married	45.9 (10.6)		52.6 (9.4)	
Never married	45.2 (10.9)		51.7 (9.7)	
Divorced/Separated	45.6 (11.6)		49.3 (11.3)	
Widowed	41.7 (11.4)	<.0001	51.6 (10.5)	<.0001
Housing tenure				

Owns home	45.4 (10.8)		42.3 (9.7)	
Rents home	43.8 (12.6)		48.4 (11.5)	
Other	41.6 (11.9)	0.002	49.9 (12.1)	<.0001
Qualification				
Post high school qualification	45.7 (10.8)		52.3 (9.4)	
High school education	44.0 (11.1)	0.0005	51.2 (10.5)	0.01
Pension				
Pension and other income	43.3 (11.0)		52.1 (10.3)	
Other income only	47.3 (9.7)		53.4 (8.4)	
Unknown source	49.9 (8.1)		51.9 (9.4)	
Pension only	42.1 (11.7)	<.0001	51.1 (10.7)	0.0004
BMI				
<18.5	37.3 (13.4)		48.5 (12.1)	
≥ 18.5- <25	46.4 (10.5)		51.5 (10.0)	
≥ 25 - <30	46.0 (10.5)		52.4 (9.5)	
≥ 30	42.6 (11.4)	<.0001	51.6 (10.3)	0.0717
Self-rated Health				
Excellent/Good	47.6 (9.4)		53.3 (8.9)	
Fair/Poor	35.0 (11.2)	<.0001	46.2 (11.8)	<.0001
Walking disability				
No	46.2 (10.1)		52.1 (9.7)	
Yes	29.7 (10.5)	<.0001	49.8 (12.4)	0.017
Disabilities				
Less than two disabilities	48.8 (9.1)		52.4 (9.5)	

Two or more	40.9 (11.3)	<.0001	51.5 (10.3)	0.283

* P value calculated from independent t-tests.

Table 2 Adjusted mean SF-36 scores[a] and differences between food secure and food insecure groups

	Food security status				
	Food secure Mean (SE)	Food Insecure Mean (SE)	Adjusted Mean Difference[a] (95% CIs)	*P* value[c]	Effect Size[b]
SF-36 Domains					
Physical Functioning	53.4 (1.4)	47.0 (1.8)	6.4 (3.9, 9.0)	<.0001	0.36
Role Limit – Physical	43.0 (2.8)	31.1 (3.5)	11.8 (6.8, 16.8)	<.0001	0.34
Bodily Pain	58.7 (1.7)	50.9 (2.2)	7.8 (4.7, 10.9)	<.0001	0.36
General Health	53.9 (1.3)	49.9 (1.6)	4.0 (1.6, 6.4)	0.0009	0.24
Vitality	49.9 (1.4)	44.5 (1.8)	5.5 (2.9, 8.1)	<.0001	0.31
Social Functioning	69.7 (1.7)	63.3 (2.1)	6.3 (3.3, 9.3)	<.0001	0.30
Role Limit – Emotional	69.2 (2.6)	51.2 (3.2)	18.0 (13.4, 22.6)	<.0001	0.57
Mental Health	74.7 (1.3)	69.6 (1.6)	5.1 (2.8, 7.4)	<.0001	0.32
SF-36 Component Scores					
Physical Component Score	36.5 (0.7)	34.1 (0.8)	2.4 (1.2, 3.5)	<.0001	0.29
Mental Component Score	49.3 (0.8)	45.7 (0.9)	3.6 (2.3, 5.0)	<.0001	0.39

RMES: Root Mean Square Error; SE: Standard Error

[a] Adjusted for Total Diet Score, age group, gender, marital status, source of income, BMI, hypertension, walking disability, Angina, arthritis, two or more health conditions and self-rated health. Food security and self-rated health significant interaction and included in the model.

[b] Effect size calculated using RMSE $((X_1 - X_2)/\text{RMSE})$

[c] *P* value calculated from independent samples *t*-tests

Table 3 Adjusted mean SF-36 scores[a] across quartiles of TDS and adjusted mean differences between the highest and lowest quartiles of TDS

	Total Diet Score							
	Quartile 1 Mean (SE)	Quartile 2 Mean (SE)	Quartile 3 Mean (SE)	Quartile 4 Mean (SE)	*P*-value for trend	Adjusted Mean Difference[a] (Q4-Q1)	*P* value[c]	Effect Size[b]
SF-36 Domains								
Physical Functioning	47.7 (1.6)	50.2 (1.6)	50.8 (1.6)	52.2 (1.6)	<.0001	4.5 (1.7, 7.3)	0.0002	0.25
Role Limit – Physical	36.6 (3.1)	38.2 (3.2)	36.1 (3.1)	37.3 (3.2)	0.936	0.7 (-4.7, 6.2)	0.987	0.02
Bodily Pain	54.6 (1.9)	55.0 (2.0)	53.6 (1.9)	56.1 (2.0)	0.426	1.5 (-1.8, 4.9)	0.645	0.07
General Health	51.2 (1.5)	50.8 (1.5)	52.6 (1.5)	52.9 (1.5)	0.04	1.8 (-0.8, 4.3)	0.306	0.11
Vitality	44.8 (1.6)	46.5 (1.6)	48.5 (1.6)	49.0 (1.6)	<.0001	4.1 (1.3, 7.0)	0.0009	0.23
Social Functioning	64.8 (1.9)	67.7 (1.9)	66.7 (1.9)	66.9 (1.9)	0.139	2.1 (-1.2, 5.4)	0.341	0.10
Role Limit – Emotional	56.2 (2.9)	61.4 (2.9)	62.1 (2.8)	61.0 (2.9)	0.009	4.8 (-0.2, 9.8)	0.066	0.15
Mental Health	70.8 (1.4)	71.8 (1.5)	73.5 (1.4)	72.6 (1.5)	0.02	1.8 (-0.7, 4.3)	0.255	0.11
SF-36 Component Scores								
Physical component score	35.1 (0.7)	35.4 (0.8)	34.9 (0.7)	35.9 (0.8)	0.2185	0.8 (-0.5, 2.1)	0.362	0.10

Mental component score	46.4 (0.8)	47.5 (0.8)	48.4 (0.8)	47.8 (0.9)	0.005	1.3 (-0.1, 2.8)	0.083	0.14

RMES: Root Mean Square Error; SD: Standard Error

[a] Adjusted for Total Diet Score, age group, gender, marital status, source of income, BMI, hypertension, walking disability, Angina, arthritis, two or more health conditions and self-rated health. Food security and self-rated health significant interaction and included in the model.

[b] Effect size calculated using RMSE $((X_1 - X_2)/\text{RMSE})$

[c] *P*-value after Tukey's adjustment for multiple comparisons

Table 4 Mean SF-36 component scores according to quartiles of diet quality and food security status

	Total Diet Score				
	Quartile 1 (n=659) Mean (SD)	Quartile 2 (n=655) Mean (SD)	Quartile 3 (n=656) Mean (SD)	Quartile 4 (n=666) Mean (SD)	*P*-value for trend**
Physical component score					
Food secure	45.3 (11.0)	45.7 (10.4)	45.3 (10.8)	46.3 (10.4)	0.186
Food insecure	41.8 (12.7)	40.8 (12.7)	40.4 (11.9)	43.8 (11.5)	0.322
P value	0.008	0.0003	0.0001	0.04	
Mental component score					
Food secure	51.4 (10.4)	52.3 (9.5)	53.7 (8.8)	53.3 (9.0)	<.0001
Food insecure	45.7 (11.3)	46.9 (10.8)	47.3 (11.4)	48.1 (12.0)	0.175
P value	<.0001	<.0001	<.0001	<.0001	

SD: Standard Deviation

**P* value was the difference in SF-36 summary scales between the food secure group and food insecure group stratified by quartile of TDS

***P*-value for trend based on the median of each TDS quartile as a continuous variable

Appendix I. Blue Mountains Eye Study 12-item food security survey

Question
A. I worry whether my food will run out before I get money to buy more
B. I worry about whether the food that I can afford to buy for my household will be enough
C. The food that I bought just didn't last, and I didn't have money to get more
D. I ran out of the foods that I needed to put together a meal and I didn't have money to get more
E. We eat the same thing for several days in a row because we only have a few different kinds of food on hand and don't have money to buy more
F. I am often hungry, but I don't eat because I can't afford enough food
G. I eat less than I think I should be cause I don't have enough money for food
H. I can't afford to eat properly
I. Sometimes people lose weight because they don't have enough to eat. In the past year, did you lose weight because there wasn't enough food?
J. In the past year, have you had hunger pangs but couldn't eat because you couldn't afford food?
K. In the last 12 months, were there times that your household ran out of food and there wasn't money to buy any more food?
L. In the last 12 months, has anyone in your household eaten less than they should because you couldn't afford enough food?

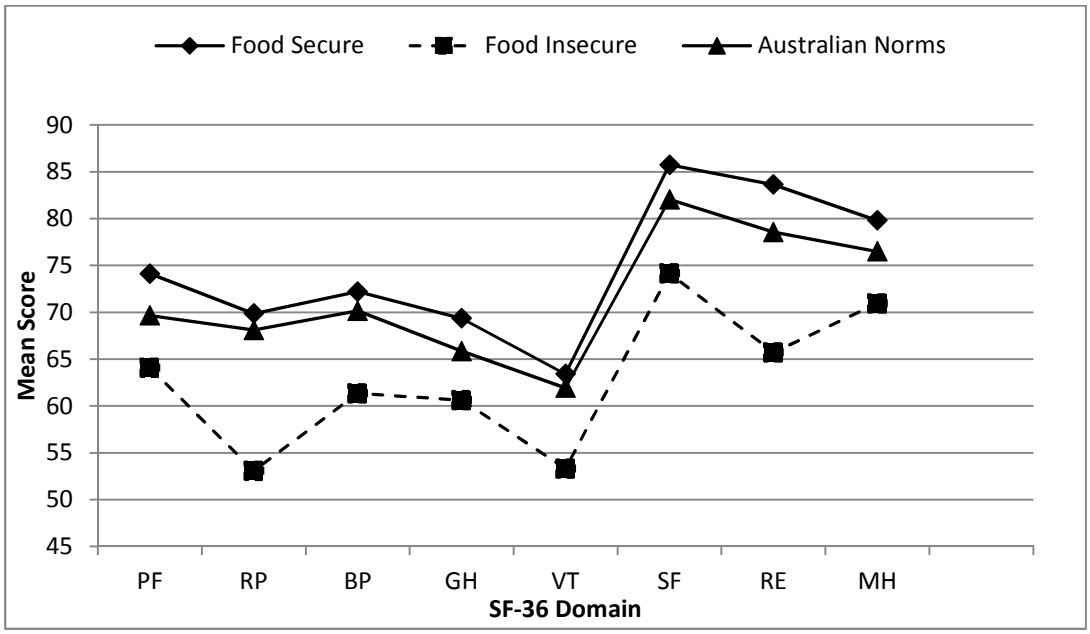

Figure 1 Unadjusted mean SF-36 domain scores by food security status compared to the Australian norms of adults aged 45 years and over[24]

(PF= Physical functioning; RP = Role limitations due to physical problems; BP = Bodily pain; GH = General Health; VT = Vitality; SF = Social functioning; RE = Role limitations due to emotional problems; MH = Mental Health)