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Published in:
British Journal of Health Psychology

DOI:
10.1111/bjhp.12656

Received: 28 June 2022 | Accepted: 27 February 2023

DOI: 10.1111/bjhp.12656

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promoting excellence in psychology

ARTICLE

A longitudinal analysis of Australian women's fruit and vegetable consumption and depressive symptoms

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Funding information

Australian Government Research Training Programme (RTP)

Abstract

Background: In Australia, women report higher rates of depressive symptoms than men. Research suggests that dietary patterns rich in fresh fruit and vegetables could protect against depressive symptoms. The Australian Dietary Guidelines suggest that consuming two servings of fruit and five serves of vegetables per day is optimal for overall health. However, this consumption level is often difficult for those experiencing depressive symptoms to achieve.

Aims: This study aims to compare diet quality and depressive symptoms in Australian women over time using (I) two serves of fruit and five serves of vegetables per day (FV7), and (ii) two serves of fruit and three serves of vegetables per day (FV5).

Materials and Methods: A secondary analysis was conducted using data from the Australian Longitudinal Study on Women's Health over 12 years at three time points 2006 (n = 9145, Mean age = 30.6, SD = 1.5), 2015 (n = 7186, Mean age = 39.7, SD = 1.5), and 2018 (n = 7121, Mean age = 42.4, SD = 1.5).

Results: A linear mixed effects model found, after adjusting for covarying factors, a small significant inverse association between both FV7 (b = −.54, 95% CI = −.78, −.29) and FV5 (b = −.38, 95% CI = −.50, −.26) in depressive symptoms.

Discussion: These findings suggest an association between fruit and vegetable consumption and decreased depressive symptoms. The small effect sizes indicate caution should be taken in interpreting these results. The findings also suggest that current Australian Dietary Guideline recommendations

need not be prescriptive to two fruit and five vegetables for impact on depressive symptoms.
Conclusions: Future research could evaluate reduced vegetable consumption (three serves per day) in identifying the protective threshold for depressive symptoms.

KEYWORDS
ALSWH, depression, depressive symptoms, diet quality, dietary patterns

Statement of Contribution

What is already known?

- Over 350 million people in the world experience the symptoms of depression.
- Current treatment options (medications, talking therapy and ECT) are only effective for a third of these people.
- Increased plant consumption has been found to decrease depressive symptoms.
- But, fruit and vegetable dietary guidelines are difficult to achieve for those experiencing symptoms of depression.

What does this study add?

- Across 12 years, only 4% of women consumed the recommended servings of fruit and vegetables daily.
- There was a comparable association between two and five and two and three serves of fruit and vegetables and depressive symptoms.
- National dietary guidelines need not be prescriptive for impact on depressive symptoms.

BACKGROUND

There are over 350 million people living globally who experience symptoms of depression (World Health Organization, 2017). In Australia, depression prevalence was 10% in 2017, with women recording higher rates (12%) than men (9%; Australian Bureau of Statistics, 2019). Depression is a multifactorial and complex disorder, and research proposes that a wide variety of factors could influence its heterogeneous and complex nature (Strakowski, 2012). Some biological factors include decreased monoamine function, dysfunctional hypothalamic pituitary adrenal (HPA) axis, neuro-progression/brain plasticity, mitochondrial disturbances (Lopresti et al., 2013; Pereira et al., 2020), cytokine-mediated inflammatory processes, increased oxidative stress, immune responses (Berk et al., 2013), immuno-inflammation, gut dysbiosis and gut/brain relationship (Kaplan et al., 2015; Pereira et al., 2020). While these biological factors play a role in the experience of depressive symptoms, they are also influenced by a diet rich in plant-based foods such as fruit and vegetables (Bayes et al., 2021; Daneshzad et al., 2020; Nguyen et al., 2017; Walsh et al., 2023).

Over the last decade, there has been an increase in research on the relationship between dietary patterns and depression in epidemiological studies (Firth et al., 2020; Jacka, 2017; Owen & Corfe, 2017). Dietary patterns are defined as 'the quantity, variety, or combination of different foods and beverages in a diet and the frequency with which they are habitually consumed' (Sánchez-Villegas et al., 2018, p. 4). Clinical trials suggest that high-quality dietary patterns rich in plant-based foods such as fruits, vegetables, legumes, whole grains, seeds and nuts are protective against symptoms of depression (Francis et al., 2019;

Jacka et al., 2017; Parletta et al., 2017). Specifically, the components of a diet high in fruits and vegetables such as antioxidants (Bayes et al., 2019), probiotics, prebiotics (Ruixue et al., 2016), complex carbohydrates (Gangwisch et al., 2015), minerals and vitamins such as zinc, selenium and magnesium (McMartin et al., 2013) could play a role in this protective effect (Lee et al., 2021).

The research on the association between fruit and vegetable consumption and depression risk is new and emerging. While meta-analyses (Kawada, 2018; Liu et al., 2016) and a systematic review of 61 studies (Głąbska et al., 2020) report that increased intake of fruit and vegetables (equal to or greater than the dietary guidelines) may be protective against depressive symptoms, evidence from primary research is inconsistent. A 14-day pre-registered clinical intervention in New Zealand ($n = 171$) found no impact of an additional two servings of fruit and vegetables per day on depressive symptoms in young adults compared to diet as a usual control (Conner et al., 2017). However, in a follow-up cross-sectional study ($n = 422$), the same research team found that after adjusting for covariates, fresh fruit and vegetable consumption predicted decreased depressive symptoms ($B = -1.52$, $SE = .40$) and increased mood ($B = .14$, $SE = .03$) compared to cooked, canned and processed fruit and vegetables (Brookie et al., 2018). Currently, research that focuses on fruit and vegetable consumption and depressive symptoms are observational, epidemiological studies that use recommended daily allowances suggested by the national dietary guidelines for overall health for that country or the World Health Organization recommendations (Blanchflower et al., 2013; Dharmayani et al., 2022; Hoare et al., 2018; Ocean et al., 2019). In Australia the Australian Dietary Guideline (ADG), recommendations are two serves of fruit and five serves of vegetables per day (National Health and Medical Research Council, 2016), but it may be difficult to meet these guidelines for those who are experiencing the symptoms of depression (Dharmayani et al., 2022).

The current literature on dietary patterns and depressive symptoms suggests that people who experience the symptoms of depression are more likely to prefer ultra-processed, palatable, and convenient foods to fresh whole foods, and this preference makes it difficult for this population to adhere to the amounts of healthy foods recommended by the ADG (Jacka et al., 2015; Ljungberg et al., 2020; Sánchez-Villegas et al., 2012). Research also indicates that while more than 50% of the Australian population are able to consume two serves of fruit in line with the ADGs, less than 4% are eating the recommended five serves of vegetables per day (Australian Institute of Health and Welfare, 2018; Lee et al., 2022). This may be due to vegetables tasting more bitter and normally incorporated in meals rather than eaten alone like sweeter tasting fruit (Hoppu et al., 2021). For those experiencing depressive symptoms with a preference for convenience foods, vegetables may be more difficult to consume than palatable, easy-to-stomach snack foods (Ljungberg et al., 2020). Contrastingly, those free from depressive symptoms may find it easier to source, cook and consume more vegetables and are less reliant on ultra-processed, convenience foods (Tuck et al., 2019). Therefore, assessing whether a reduction in the recommended daily allowance for fruit and vegetable consumption for depressive symptoms could make consuming healthy foods in this population more manageable (Konttinen, 2020). This is particularly pertinent for women who experience the symptoms of depression at higher levels than men (Australian Bureau of Statistics, 2018).

One longitudinal study that examines diet quality using fruit and vegetable consumption and depressive symptoms is the Australian Longitudinal Study on Women's Health (2020). Previous research using ALSWH data has examined the independent associations between fruit and vegetable consumption and depressive symptoms using generalized estimating equations (Mihrshahi et al., 2015). After adjusting for covariates, they found decreased odds of depressive symptoms in women who ate more than two serves of fruit per day (OR = .86, 95% CI: .79–.95) and five or more serves of vegetables per day (OR = .79, 95% CI: .67–.93). Similarly, another longitudinal study using generalized estimating equations by the same authors found that four serves of fruit (OR = .75, 95% CI: .57, .97) and five serves of vegetables (OR = .81, 95% CI: .70, .94) was associated with lower odds of depressive symptoms than consuming one serve or less (Dharmayani et al., 2022). However, no previous research has examined how combining fruit and vegetable consumption relates to depressive symptoms within this data set.

The amount of fruit and vegetable consumption that produces protective effects on depressive symptoms is unclear. The current Australian Dietary Guidelines (ADG; National Health and Medical Research Council, 2016) do not specify the beneficial amounts for positive mental health. However, in a

meta-analysis of 26 international cohort studies including over 1.9 million participants, Wang et al. (2021) reported that the optimal serving for lower mortality and overall health is two serves of fruit and three vegetables per day (FV5). Their meta-analysis found that consuming seven servings of fruits and vegetables in total as recommended by the ADG was no more beneficial for health and reduced mortality than eating five servings per day. Other researchers agree, suggesting that the diversity of fruit and vegetables (more than 30 different types of plants per week), is more beneficial for health outcomes than the quantity of fruits and vegetables consumed (McDonald et al., 2018).

While current research suggests that diversity and reduced intake of vegetables may be beneficial for physiological health, this association has not yet been addressed in the research focused on fruit and vegetable consumption and depressive symptoms. Therefore, a comparison between the current ADGs (two fruit and five vegetables per day) and Wang et al. (2021) recommendations (two fruit and three vegetables per day) and depressive symptoms could clarify this relationship. To fill this gap in the literature, we conducted a secondary analysis of the ALSWH data exploring two research questions:

i. Is there a longitudinal association between the consumption of two fruit and five serves of vegetables per day and depressive symptoms over time in Australian women?
ii. Is there a longitudinal association between the consumption two fruit and three serves of vegetables per day and depressive symptoms over time in Australian women?

The sample was sourced from the 1973 to 1978 cohort of the ALSWH including data from three time points; 2006 (n = 9145, Mean age = 30.6, SD = 1.5), 2015 (n = 7186, Mean age = 39.7, SD = 1.5) and 2018 (n = 7121, Mean age = 42.4, SD = 1.5) measuring fruit and vegetable consumption, depressive symptoms and covariates at all time points.

METHODS

Participants

The ALSWH (2020) has recruited more than 50,000 women in Australia in a continuing longitudinal study randomly selected from Medicare – Australia's national healthcare database. Women are divided into age cohorts: born between 1921 and 1926, 1946 and 1951, 1973 and 1978, 1989 and 1995 (Lai et al., 2016; Lee et al., 2005; Mishra et al., 2014). Response rates for the cohort used in this analysis (1973–1978) were 41%–42%. Respondents of the ALSWH completed surveys every 3–4 years from 1996 to 2018 containing health-related questions. Ethical approval was given by the Australian Human Research Ethics Committees of the University of Queensland) and the University of Newcastle and followed the Declaration of Helsinki guidelines (World Medical Association, 2018). Informed consent was collected from all participants prior to inclusion in the study (ALSWH, 2020). At the final time point (2018), the mean age of women in the cohort chosen for this analysis (1973–1978) was 42 years (SD = 1.5). Participant sample size was measured at three time points 2006 (n = 9145), 2015 (n = 7186) and 2018 (n = 7121) where fruit and vegetable consumption, depressive symptoms and all covarying factors were measured.

Materials

Depressive symptoms (CESD-10)

The Centre for Epidemiological Studies Depression short form (CESD-10) was used to measure depressive symptoms over the past week (Andresen et al., 1994). The CESD-10 is a 10-item short form of the original 20-item CESD scale (Radloff, 1977). Items are responded to on a 4-point Likert scale: 0 (none

of the time) to 3 (all of the time). Total summed scores range from 0 to 30, with higher scores (>10) suggesting a greater experience of depressive symptoms. The CESD-10 measures depressive symptoms in the general population and is not used as a clinical diagnostic tool. (Radloff, 1977). It has test–retest reliability, high internal consistency (a = .88) and concurrent validity with the Beck depression scale (Zhang et al., 2012).

Diet quality measure I: Fruit and vegetable intake (FV7)

Diet quality was measured using fruit and vegetable intake based on the ADG (National Health and Medical Research Council, 2016) recommendations at three time points in the selected cohort (2006, 2015 and 2018). Respondents were asked to answer two questions: (i) *How many pieces of fruit do you eat on average per day?* and (ii) *how many serves of vegetables do you eat on average per day?* Indicators that defined a healthy diet were attributed to the consumption of two or more serves of fruit plus five or more serves of vegetables per day (FV7), (National Health and Medical Research Council, 2016). In the current analysis, the FV7 is constructed as a binary variable – healthy or unhealthy.

Diet quality measure II: Fruit and vegetable intake (FV5)

For the second measure of diet quality, two or more serves of fruit and three or more serves of vegetables per day (FV5) were classified as healthy, otherwise unhealthy, in line with Wang et al.'s (2021) recommendations. The FV5 is also constructed as a binary variable – healthy or unhealthy.

Covariates

Potential covarying factors that were considered a priori included: BMI measured using weight (kg)/height (m^2), social functioning measured by averaging Social Functioning 36 (SF36) total score (Lassale et al., 2009), clinically diagnosed anxiety (yes/no), alcohol status (non-drinker, low-risk drinker, rarely drinks, risky drinker, high-risk drinker), smoking status (never smoked, ex-smoker, smokes <10 per day, smokes 10–19 per day, smokes >20 per day, unknown), marital status (married, de facto, separated, divorced, widowed, never married) and education levels (no qualification, school certificate, higher school certificate, trade certificate, diploma, undergraduate degree, postgraduate degree).

Data analysis strategy

Using Stata v16 statistical software, descriptive statistics for all three time points were reported using mean, standard deviation, boxplots and histograms for continuous variables (CESD-10, SF36, age) and percentages, frequencies and bar charts for categorical variables (FV7, FV5, BMI, clinically diagnosed depression and anxiety, education levels, marital, smoking and alcohol status). Assumptions of linear mixed effect models (LMM) were tested using a scatterplot of residuals and histograms for linearity and equal variance (Gelman & Hill, 2006). Probability–probability (pp) plots and quantile–quantile (qq) plots demonstrated normality. Significant log-ratio tests and a substantial reduction in Akaike Information Criteria (AIC) were used to show model fit (Fitzmaurice et al., 2012). Only data that were complete for all participants at all three time points were included in the model (n = 7121).

A linear mixed effect model was used to predict depressive symptoms (continuous CESD-10 score) as a function of diet quality measured using FV7 (healthy and unhealthy) and year (2006, 2015 and 2018), with participant as a random effect, i indicating individual and j indicating time:

$$\begin{aligned}\text{CESD-10}_{ij} = \alpha + \beta_1 \text{FV7}_{ij1} + \beta_2 \text{year}_{ij2} + \beta_3 \text{BMI}_{ij3} + \beta_4 \text{social function}_{ij4} \\ + \beta_5 \text{anxiety}_{ij5} + \beta_6 \text{alcohol status}_{ij6} + \beta_7 \text{smoking status}_{ij7} \\ + \beta_8 \text{marital status}_{ij8} + \beta_9 \text{education level}_{ij9} + b(\text{participant})_i + \varepsilon_{ij}.\end{aligned}$$

An identical modelling process in model one was applied to model two with diet quality measured using FV5 (healthy and unhealthy). The second model is formulated as follows:

$$\begin{aligned}\text{CESD-10}_{ij} = \alpha + \beta_1 \text{FV5}_{ij1} + \beta_2 \text{year}_{ij2} + \beta_3 \text{BMI}_{ij3} + \beta_4 \text{social function}_{ij4} \\ + \beta_5 \text{anxiety}_{ij5} + \beta_6 \text{alcohol status}_{ij6} + \beta_7 \text{smoking status}_{ij7} \\ + \beta_8 \text{marital status}_{ij8} + \beta_9 \text{education level}_{ij9} + b(\text{participant})_i + \varepsilon_{ij}.\end{aligned}$$

The final models were analysed at all three time points (2006, 2015 and 2018) with CESD-10 as the outcome, FV7/FV5 as predictors and covariates of BMI, social functioning, anxiety, alcohol, smoking, marital and education status were added stepwise.

RESULTS

Participant characteristics

As displayed in Table 1, participant characteristics consisted of 9145 at baseline (2006, Mean age = 30.6, *SD* = 1.5); 7186 in 2015 (Mean age = 39.7, *SD* = 1.5) and 7121 in 2018 (Mean age = 42.4, *SD* = 1.5). At the final time point in 2018, 78% were in a partnered relationship, 86% had completed a trade certificate or university degree, 54% were classified as overweight or obese using BMI scoring compared to 42% in 1996, while 4% (2006), 4% (2015) and 6% (2018) of participants were classified as having an overall healthy fruit and vegetable consumption in line with the ADG. Whereas 36% (2006), 27% (2015) to 27% (2018) were considered to have healthy consumption using two fruit and three vegetables. Of the 7121 women surveyed in 2018, 90% had consumed alcohol, 38% had smoked in the previous week and 14% self-reported diagnosis of anxiety. In relation to depression, 14% (2006), 16% (2015) and 16% (2018) of the cohort were clinically diagnosed with depression, while CESD-10 scores across the cohort fell below the cut-off for experiencing depressive symptoms 6.5 (*SD* = 5.3) in 2006, 6.6 (*SD* = 5.5) in 2015 and 6.7 (*SD* = 5.6) in 2018.

Linear mixed effect model one: diet quality (FV7) and depressive symptoms (CESD-10)

In the unadjusted model, there was a small but significant inverse association between FV7 and CESD-10 ($b = -.44$, $p < .001$), indicating that there is a .44-point reduction in depressive symptoms for healthy compared with unhealthy fruit and vegetable consumption (Supporting Information).

There was no significant interaction between FV7 and year. Therefore, only the main effects were included in the adjusted model. After adjusting for all covariates, there was a significant inverse association between FV7 and CESD-10 ($b = -.54$, 95% CI: −.78, −.29), indicating that for each increase in mean diet quality from unhealthy intake to healthy intake, there is a .54-point decrease in depressive symptoms (Table 2).

Linear mixed effect model two: diet quality (FV5) and depressive symptoms (CESD-10)

In the unadjusted model, there was a small but significant inverse association between FV5 and CESD-10 ($b = -.67$, $p < .001$), indicating that for each score increase in mean diet quality (healthy/unhealthy), as

TABLE 1 Participant characteristics over time.

	2006 (n = 9145)	2015 (n = 7186)	2018 (n = 7121)
Marital status (n, %)			
Partnered	6587 (72%)	5433 (80%)	5313 (78%)
Unpartnered	2519 (28%)	1385 (20%)	1471 (22%)
Total	9106	6818	6784
Smoking status (n, %)			
Never smoked	5288 (58%)	4293 (62%)	4254 (62%)
Ex-smoker	2018 (22%)	1941 (28%)	1.947 (28%)
Smokes <10 day	869 (10%)	345 (5%)	361 (5%)
Smokes 10–19 day	609 (7%)	242 (3%)	213 (3%)
Smokes >20 day	314 (4%)	134 (2%)	122 (2%)
Smokes unknown			
Total	9098	6955	6897
Alcohol status (n, %)			
Non-drinker	948 (10%)	746 (11%)	712 (10%)
Low-risk drinker	5467 (60%)	4079 (59%)	4052 (59%)
Rarely drinks	2343 (26%)	1673 (24%)	1641 (24%)
Risky drinker	301 (3%)	375 (5%)	401 (6%)
High-risk drinker	41 (<1%)	90 (1%)	97 (1%)
Total	9100	6963	6903
BMI (n, %)			
Underweight	315 (4%)	123 (2%)	108 (2%)
Normal weight	4895 (55%)	3110 (45%)	2704 (40%)
Overweight	2141 (24%)	1886 (27%)	1974 (29%)
Obese	1574 (18%)	1797 (26%)	2038 (30%)
Total	8925	6916	6824
Diagnosed depression (n, %)			
Yes	1163 (14%)	1123 (16%)	1068 (16%)
No	7449 (87%)	5948 (84%)	5768 (84%)
Total	8612	7071	6836
Diagnosed anxiety (n, %)			
Yes	623 (7%)	823 (12%)	919 (13%)
No	7989 (93%)	6248 (88%)	5917 (87%)
Total	8612	7071	6836
FV7 (n, %)			
Healthy	315 (4%)	413 (6%)	427 (6%)
Unhealthy	8821 (97%)	6407 (94%)	6358 (94%)
Total	9136	6820	6785
FV5 (n, %)			
Healthy	3236 (36%)	1844 (27%)	1806 (27%)
Unhealthy	5900 (65%)	4976 (73%)	4979 (73%)
Total			
Age (years; M, SD)	30.6 (1.5)	39.7 (1.5)	42.4 (1.5)

(Continues)

TABLE 1 (Continued)

	2006 (n = 9145)	2015 (n = 7186)	2018 (n = 7121)
CESD-10 (*M*, *SD*)	6.5 (5.3)	6.6 (5.5)	6.7 (5.6)
SF36 SF (*M*, *SD*)	81.1 (22.4)	81.1 (23.2)	79.6 (24.0)

Abbreviations: BMI, Body Mass Index; CESD-10, Centre for Epidemiological Studies Depression Score; FV7, two fruit and five vegetables; SF36 SF, Medical Outcomes Short Form – Social Function Score.

measured by the FV5, there is a .67-point reduction in depressive symptoms, as measured by the CESD-10 total score (Supporting Information).

There was no significant interaction between FV5 and year. Therefore, only the main effects were included in the adjusted model. After adjusting for all covariates in the model, there was a small but significant inverse association between FV5 and CESD-10 (b = −.38, 95% CI: −.50, −.26), indicating that for a mean increase in diet quality from unhealthy to healthy diet quality as measured by the FV5, there is a .38-point reduction in depressive symptoms as measured by the CESD-10 total score (Table 3).

DISCUSSION

This analysis from the ALSWH data measured diet quality using two fruit and vegetable consumption measures at three time points, 2006, 2015 and 2018 – two fruit and five vegetables (FV7) in line with ADG recommendations and two fruit and three vegetables per day (FV5) in line with Wang et al. (2021) recommendations. According to the ADG recommendations, only 4% (2006), 6% (2015) and 6% (2018) of women in this study were classified with overall healthy consumption of fruit and vegetable. These figures are similar to the Australian Institute of Health and Welfare (2018) data that found only 8% of Australians were eating the recommended serving of fruit and vegetables per day, suggesting that meeting the dietary guidelines is already difficult for those in the general population before taking into consideration the added complexity for those experiencing depressive symptoms (Ljungberg et al., 2020). When assessing adherence to fruit and vegetable intake in line with Wang et al. (2021) recommendations, 36% (2006), 27% (2015) and 27% (2018) were classified with overall healthy consumption of fruit and vegetables, indicating that reducing vegetable intake by two serves per day notably increased adherence to the recommendations. This is an important finding for those experiencing depressive symptoms as they may find it easier to adhere to a reduced number of vegetables per day (Dharmayani et al., 2022).

In model one of this study, the ADG recommendations of daily consumption of two fruits and five vegetables (FV7) were used to measure diet quality. After adjusting for covariates, the difference between unhealthy and healthy consumption in line with the ADG recommendations for fruit and vegetable consumption resulted in a small but significant decrease in depressive symptoms. Comparatively, in model two, Wang et al.'s (2021) recommendations of two serves of fruit and three serves of vegetables per day were examined. After adjusting for covariates, the difference between unhealthy and healthy consumption in line with Wang et al. (2021) recommendations for fruit and vegetable consumption also resulted in a small but significant decrease in depressive symptoms. This suggests that women experiencing depressive symptoms would have a similar decrease in symptoms by eating both five and three serves of vegetables per day.

Fruit and vegetables are good sources of nutrients suggested to reduce the risk of depressive symptoms (Lee & Bradbury, 2018). Antioxidants, which give fruits and vegetables their bright, vibrant colours, protect against oxidative stress and inflammation, biological mechanisms that can have been found to increase the risk of depressive symptoms (Palta et al., 2014). Dietary fibre, high in fruits and vegetables, has been shown to have positive impacts on the health of the gut microbiome and indirectly impacts mood and depressive symptoms through the gut/brain connection (Berding et al., 2021). Similarly, pre and probiotics promote the growth and diversity of the millions of bacteria in the gut microbiome, regu-

TABLE 2 Adjusted model of FV7 on CESD-10 (standardized and unstandardized beta coefficients).

	b	*β*	*SE*	*z*	*p*	CI
FV7						
Unhealthy						
Healthy	−.54	−.02	.126	−4.26	<.001	(−.78, −.29)
Year						
2006						
2015	−.06	.00	.061	.92	.357	(−.06, .18)
2018	−.10	−.01	.063	−1.65	.100	(−.23, .20)
Anxiety						
No						
Yes	1.56	.09	.096	16.22	<.001	(1.37, 1.74)
BMI	.06	.07	.005	11.31	<.001	(.05, .07)
Social function	−.13	−.53	.001	−97.49	<.001	(−.13, −.12)
Alcohol status						
Non-drinker						
Low-risk drinker	−.10	−.01	.102	−1.02	.307	(−.30, .10)
Rarely drinks	.08	.00	.107	.07	.943	(−.20, .22)
Risky drinker	.51	.02	.161	3.15	.002	(.19, .82)
High-risk drinker	1.31	.02	.301	4.35	<.001	(.72, 1.90)
Smoking status						
Never smoked						
Ex-smoker	.22	.02	.077	2.82	.005	(.07, .37)
Smokes <10 day	.47	.02	.122	3.82	<.001	(.23, .70)
Smokes 10–19 day	.75	.03	.147	5.12	<.001	(.47, 1.04)
Smokes ≥20 day	1.34	.04	.197	6.79	<.001	(.95, 1.73)
Marital status						
Married						
Defacto	−.11	.01	.085	1.32	.187	(−.05, .28)
Separated	1.14	.04	.154	7.39	<.001	(.83, 1.44)
Divorced	.45	.02	.152	2.95	.003	(.15, .74)
Widowed	1.78	.02	.519	3.43	.001	(.77, 2.80)
Never Married	.74	.05	.088	8.40	<.001	(.67, .91)
Education level						
No qualification						
Year 10	−.87	−.04	.370	−2.37	.018	(−1.60, −.15)
Year 12	−.93	−.06	.360	−2.58	.10	(−1.63, −.22)
Trade certificate	−1.23	−.04	.396	−3.11	.002	(−2.01, −.45)
Diploma	−1.10	−.09	.355	−3.11	.002	(−1.80, −.41)
Undergraduate	−1.40	−.12	.356	−3.94	<.001	(−2.10, −.71)
Postgraduate	−1.40	−.11	.358	−3.92	<.001	(−2.11, −.70)

Abbreviations: *b*, unstandardized beta coefficient; BMI, Body Mass Index; CESD-10, Centre for Epidemiological Studies Depression Score; FV7, two fruit and five vegetables; *β*, standardized beta coefficient.

TABLE 3 Adjusted model of FV5 on CESD-10 (standardized and unstandardized beta coefficients).

	b	*β*	*SE*	*z*	*p*	CI
FV5						
Unhealthy						
Healthy	−.38	−.03	.063	−6.10	<.001	(−.50, −.26)
Time point						
Four						
Seven	.01	.00	.062	.08	.936	(−.12, .13)
Eight	−.16	−.01	.064	−2.51	.012	(−.28, .03)
Anxiety						
No						
Yes	1.56	.09	.096	16.22	<.001	(1.37, 1.74)
BMI	.06	.07	.005	11.13	<.001	(.05, .07)
Social function	−.13	−.53	.001	−97.49	<.001	(−.13, −.12)
Alcohol status						
Non-drinker						
Low-risk drinker	−.11	−.01	.102	−1.03	.301	(−.31, .09)
Rarely drinks	.01	.00	.107	.07	.947	(−.20, .22)
Risky drinker	.49	.02	.161	3.03	.002	(.17, .80)
High-risk drinker	1.29	.02	.301	4.29	<.001	(.70, 1.88)
Smoking status						
Never smoked						
Ex-smoker	.21	.02	.077	2.75	.006	(.06, .36)
Smokes <10 day	.44	.02	.122	3.58	<.001	(.20, .67)
Smokes 10–19 day	.72	.03	.147	4.85	<.001	(.43, 1.00)
Smokes ≥20 day	1.31	.04	.197	6.62	<.001	(.92, 1.69)
Marital status						
Married						
Defacto	.10	.01	.085	1.17	.243	(−.07, .26)
Separated	1.13	.04	.154	7.35	<.001	(.83, 1.43)
Divorced	.45	.02	.152	2.97	.003	(.15, .75)
Widowed	1.78	.02	.519	3.42	.001	(.76, 2.79)
Never Married	.73	.05	.088	8.32	<.001	(.56, .90)
Education level						
No qualification						
Year 10	−.87	−.04	.370	−2.35	.019	(−1.59, −.45)
Year 12	−.92	−.06	.360	−2.56	.010	(−1.63, −.22)
Trade certificate	−1.21	−.04	.396	−3.04	.002	(−1.98, −.43)
Diploma	−1.08	−.09	.355	−3.05	.002	(−1.78, −.39)
Undergraduate	−1.37	−.12	.355	−3.85	<.001	(−2.06, −.67)
Postgraduate	−1.36	−.10	.358	−3.81	<.001	(−2.07, −.66)

Abbreviations: *b*, unstandardized beta coefficient; BMI, Body Mass Index; CESD-10, Centre for Epidemiological Studies Depression Score; FV5, two fruit and three vegetable; *β*, standardized beta coefficient.

lating mood and decreasing depressive symptoms (Bayes et al., 2019). However, a study of 10,000 citizen scientists from the USA, UK and Australia found that it may be the diversity rather than the number of plants in a dietary pattern that improves health outcomes (McDonald et al., 2018). This is particularly helpful for individuals' experiencing the symptoms of depression, as they may see benefits from diversifying their fruit and vegetable intake, rather than attempting to increase the quantities that they consume.

The findings of our study were significant in both the models measuring FV7 and FV5, but both models reported small effect sizes suggesting caution should be taken in interpreting these results as clinically meaningful. Notably, the association between diet quality and depressive symptoms in model two was comparable to current ADG recommendations for health in model one. After controlling for the same variables, the effect size for two fruit and three vegetables was a .38 point reduction, and for two fruit and five vegetables was a .54 point reduction. This finding may suggest that women who experience the symptoms of depression may still benefit from a reduced number of fruit and vegetables than what is recommended in the current ADGs. However, more research is needed to explore the optimal amount of fruit and vegetables needed for a protective effect on depressive symptoms. The small effect sizes may also suggest other factors at play in the fruit and vegetable and mood relationship outside of diet quality. Factors such as socio-economic status, physical activity levels (Firth et al., 2019), individual differences, relationships with food (Lee, Bradbury, et al., 2023), social connection and social economics may all play a role in the relationship between fruit and vegetable intake and mental health outcomes (Lee, Angus, et al., 2023).

An earlier study using the ALSWH data (1946–1951 cohort) assessing fruit and vegetable consumption and depressive symptoms by Mihrshahi et al. (2015) found that after adjusting for covariates, women who ate two or more serves of fruit per day had reduced odds of depressive symptoms (OR = .86, 95% CI: .79, .95). They also reported reduced odds of depressive symptoms for those who ate five or more serves of vegetables per day (OR = .79, 95% CI: .67, .93), but no significant result for fewer than four serves (OR = .93, 95% CI: .83, 1.03) which is in contrast to the results of this current study. Similarly, another longitudinal study by the same authors found that four serves of fruit (OR = .75, 95% CI: .57, .97) and five serves of vegetables (OR = .81, 95% CI: .70, .94) were associated with lower odds of depressive symptoms than consuming one serve or less (Dharmayani et al., 2022). However, the differing findings could result from Mihrshahi et al. (2015) and Dharmayani et al. (2022) measuring fruit and vegetable as separate variables, not as a combined variable as examined in the current analysis. The current study also dichotomised participants as 'healthy' and 'unhealthy' by combining fruit and vegetable consumption in two different ways, whereas Mihrshahi et al. (2015) and Dharmayani et al. (2022) used fruit and vegetable consumption as continuous variables.

Strengths and limitations

The first strength of this longitudinal data analysis was access to a large sample of women representative of the Australian population. The ability to assess depressive symptoms specific to a female cohort is of considerable advantage, as women in Australia report higher levels of depression than men (Australian Bureau of Statistics, 2019). Another strength is that the analyses adjusted for several other predictors of depressive symptoms, including health and sociodemographic factors. A limitation is that the means of the CESD across all timepoints were beneath the cut-off for depressive symptoms, indicating an overall population that was not experiencing depressive symptoms. This may be the reason for the small effect sizes seen in the analysis, which may not translate to real-world differences for those receiving treatment for depression. Instead, it implies a promising outlook for those who currently have a healthy consumption of fruit and vegetables. Food recall was used to assess the number of fruit and vegetables that each respondent consumed on average per day over the past year. Relying on participants' memories of food intake over such a long period can be an unreliable measure influenced by social desirability bias and could impact the accuracy of the results (Shim et al., 2014). Future research could focus on assessing these relationships in a different cohort of the ALSWH. Future research could also evaluate fruit and vegetable consumption as a combined variable and reduce vegetable intake to three serves per day for identifying the protective threshold for depressive symptoms.

A longitudinal data analysis of the ALSWH data set examined two measures of fruit and vegetable consumption (two fruit and five vegetables and two fruit and three vegetables) and depressive symptoms in Australian women in 2006, 2015 and 2018. There was a small but significant association between fruit and vegetable consumption and depressive symptoms for both measures (FV5 and FV7). This study highlights small inverse findings in the association between diet quality and depressive symptoms in Australian women. Further analyses of longitudinal data and intervention studies are needed to assess causality and temporal relationships.

AUTHOR CONTRIBUTIONS

Megan Lee: Conceptualization; data curation; formal analysis; investigation; methodology; project administration; resources; software; validation; visualization; writing original draft. **Joanne Bradbury:** Conceptualization; data curation; formal analysis; supervision; writing – review and editing. **Jacqui Yoxall:** Conceptualization; supervision; writing – review and editing. **Sally Sargeant:** Conceptualization; investigation; supervision; writing – review and editing.

ACKNOWLEDGMENTS

The research on which this paper is based was conducted as part of the Australian Longitudinal Study on Women's Health by the University of Queensland and the University of Newcastle. We are grateful to the Australian Government Department of Health and Aged Care for funding and to the women who provided the survey data. The authors would like to acknowledge the guidance of biostatistician Doctor Alison Bowling with the data analysis for this project; the Australian Longitudinal Study on Women's Health for access to their data sets; the support of Professor Gita Mishra the ALSWH liaison person for our study and Professor Graham Giles and Professor Roger Milne of the Cancer Epidemiology Centre of Cancer Council Victoria, for permission to use the Dietary Questionnaire for Epidemiological Studies (Version 2), Melbourne: Cancer Council Victoria, 1996. Open access publishing facilitated by Bond University, as part of the Wiley - Bond University agreement via the Council of Australian University Librarians.

FUNDING INFORMATION

This work was supported by an Australian Government Research Training Programme (RTP) stipend grant for PhD candidate Megan Lee. RTP funding is an Australian support grant for domestic or international students conducting PhD or Master of Research degrees. The project received no other grants from funding agencies, commercial or not-for-profit sectors.

CONFLICT OF INTEREST STATEMENT

The authors acknowledge no conflict of interest for this research project.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the Australian Longitudinal Study on Women's Health. Restrictions apply to the availability of these data, which were used under licence for this study.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Lee, M., Bradbury, J., Yoxall, J. & Sargeant, S. (2023). A longitudinal analysis of Australian women's fruit and vegetable consumption and depressive symptoms. *British Journal of Health Psychology*, *00*, 1–15. https://doi.org/10.1111/bjhp.12656