Original Article

Fruit and vegetable consumption and psychological distress in Australian pregnant and breastfeeding women

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Background and Objectives: Mental health disorders amongst pregnant and postpartum women are an increasing public health concern. Our aim was to determine the association between fruit and vegetable intake and psychological distress in a nationally representative sample of Australian pregnant and breastfeeding women. **Methods and Study Design:** This study used cross-sectional data collected by the Australian Bureau of Statistics in the 2014 to 2015 Australian National Health Survey. Participants included 166 pregnant and 207 breastfeeding women >18 years old. Number of serves of fruit and vegetables usually consumed each day was reported. The Kessler Psychological Distress Scale (K10) measured levels of global non-specific psychological distress. The association between fruit and vegetable intake and psychological distress was investigated using linear regression adjusted for available known covariates (age, education, physical activity). **Results:** Mean±SD fruit intake was greater in pregnant compared to breastfeeding women (2.0±1.0 versus 1.7±1.0, $p<0.05$). The mean K10 score for both the pregnant and breastfeeding women was in the 10-15 'little or no psychological distress" range. In pregnant women, combined fruit and vegetable intake was inversely associated with psychological distress in the fully adjusted model (β=-0.37, 95% CI -0.72, -0.02). There was no association between fruit and vegetable intake and psychological distress in breastfeeding women. **Conclusions:** A higher intake of combined fruit and vegetables was found to be associated with less psychological distress in pregnant women. Further research, including longitudinal and intervention studies, are required to determine causality between fruit and vegetable intake and psychological distress in this population group.

Key Words: fruit, vegetable, pregnancy, breastfeeding, psychological distress

INTRODUCTION

Mental health disorders are a leading cause of disability worldwide.[1] Internationally, the prevalence of these disorders amongst pregnant and postpartum women is also an increasing public health concern.[2] It is estimated 20% of women globally experience antenatal depression and 12-16% of women experience postnatal depression.[3] In a nationally representative US sample, serious psychological distress was reported in 4.8% of pregnant women and 5.4% of postpartum women.[4] While there has been extensive research conducted on the prevalence of mental health disorders in postpartum women, surprisingly there is little evidence in breastfeeding women. Earlier studies have reported that breastfeeding mothers have a higher risk of depression, although some have reported lower rates of depression.[5,6] Depression originating in the postpartum period can last for months or even years.[3]

During pregnancy and postpartum, including breastfeeding women, untreated mental health issues can impact the health and wellbeing of both mother and baby. During pregnancy, poor mental health increases the risk of complications such as preeclampsia, birth complications, low infant birth weight and poor infant development, and increases the risk of developing postpartum depression.[7-9] Poor maternal health during the postpartum period has been shown to be associated with poorer adherence to guidelines and recommendations including reduced rates of breastfeeding and lower engagement around appropriate infant sleep position and use of car restraints.[10] Suicide is considered one of the leading causes of death in postnatal women.[11,12]

Treatments for mental health disorders include psychological treatments and pharmaceutical anti-depressant medications.[13] However, there are concerns using medications during pregnancy and breastfeeding, as they may have adverse effects on the foetus and/or baby.[14,15] Modifications to diet may provide a promising approach to

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preventing and managing women who already have mental health disorders, as well as having additional benefits on reducing the risk of chronic disease.[16]

The relationship between dietary intake and mental health status during pregnancy and postpartum is a growing area of interest. In a recent systematic review of cross sectional and cohort studies, healthy diets during pregnancy were reported to be inversely associated with antenatal depressive and anxiety symptoms.[17] However, there were inconsistent results with postnatal depressive symptoms. Specific food groups, such as fruit and vegetables, have received increasing attention for their potential association with mental health during the perinatal period, and this has been examined in several cross sectional studies.[18-20] Two cross sectional studies have found in pregnant women that a dietary pattern characterised by high fruit or low fruit was associated with a lower and higher prevalence of depression, respectively.[18,20] However, in a population of pregnant women, the healthy dietary pattern which included fruit and vegetables, was not associated with depressive symptoms.[19] These findings are supported by two large cross-sectional studies in the general population which have found greater consumption of fruit and vegetables is associated with lower odds of psychological distress[21] and depression.[22]

Whilst these studies have reported the relationship between fruit and vegetable intake and mental health in pregnant and postnatal women, none have examined a nationally representative Australian sample and no studies have explored these relationships among breastfeeding women. This knowledge can further strengthen the information base supporting both more powerful study designs to test these associations and in turn to inform the development of evidence based dietary strategies to prevent poor mental health in these target groups. The aim of this study was to determine the association between fruit and vegetable intake and psychological distress in an Australian sample of pregnant and breastfeeding women.

METHODS

Study design and participants

This study used cross-sectional data collected by the Australian Bureau of Statistics in the 2011-12 Australian National Health Survey (NHS).[23] The survey was conducted using a stratified multistage area sample of private dwellings (excluding very remote and Indigenous Communities). The sample selection procedure resulted in every dwelling in the same state or territory having a known probability of selection, equal to the state or territory sample fraction. Within each dwelling, one adult (18 years and over) and one child (0-17 years) were randomly selected for inclusion in the survey. The overall response rate was 84.8%, with a total of n=20,426 participants from 15,565 residences. In the survey, weighting was applied where adjusting results from the survey was used to infer results for the total in-scope population. A weight was allocated to each unit: each person or household. Participants who indicated they were either pregnant (n=165) or breastfeeding (n=207) and over 18 years old were included in the present study. Trained Australian Bureau of Statistics interviewers conducted face-to-face interviews with selected individual participants.

Ethical statement

The interview components of the NHS were conducted by the Australian Bureau of Statistics under the Census and Statistics Act 1905. All analyses of the CURF data were undertaken by SJT and AP who are registered users of the NHS CURF. The current study was approved by the Deakin University Human Research Ethics Committee (Project number 2018-201).

Dietary intake

Usual fruit and vegetable consumption was assessed using validated short questions[24] typically used in national dietary surveys.[25,26] Participants were asked to indicate the number of serves of fruit or vegetables they consumed on a usual day, with survey options ranging from "never", "less than 1 serve" through to "5 serves or more" for fruit and "6 serves or more" for vegetables.[23] A serve of vegetables was defined as: half a cup of cooked vegetables, one medium potato, one cup of salad vegetables, approximately equivalent to 75 grams. All types of vegetables were included, except legumes. A serve of fruit was defined as: one medium piece or two small pieces of fruit, one cup of diced fruit, four dried apricot halves, approximately 150 grams of fresh fruit or 50 grams of dried fruit. Fruit and vegetable juices were excluded. Prompt cards were used to assist respondents in understanding the concept of a serve, showing pictorial representations. Individual responses for the fruit and vegetables survey items were converted into fruit and vegetable intake variables for analysis as follows: "never" = 0 serves/day, "less than 1 serve" = 0.5 serve/day, "1 serve per day" = 1 serve/day, "2 serves per day" = 1 serves/day, "3 serves per day" = 3 serves/day, "4 serves per day" = 4 serves/day, "5 serves per day" =5 serves/day, "6 serves per day" = 6 serves/day. Individual scores on the fruit and vegetable intake variables were then added together to create a combined fruit and vegetable intake variable.

Psychological distress

The K10 was used to measure global non-specific psychological distress.[27,28] The scale has 10 items asking participants about signs and symptoms of depression and anxiety during the previous 4 weeks. Participants were asked to respond to questions on a five point scale, with options ranging from "1" none of the time, "2" a little of the time, "3" some of the time, "4" most of the time, to "5" all of the time. Distress scores can range from 10 to 50 and were categorised according to guidelines used by the Australian Bureau of Statistics: 10-15, little or no psychological distress; 16-21, moderate psychological distress; 22-29, high psychological distress; and 30-50, very high psychological distress.[23] This tool has been validated in pregnant women.[29]

Covariates

Covariates including maternal age, education (used as an indicator of socioeconomic position, consistent with previous studies[30]), and physical activity were collected. Education level referred to the highest level of school completed and the completion of higher education qualifications. These were classified to the Australian Standard Classification of Education (ASCED), 2001 and catego-

rized as: secondary (highest level of education being any high school year from year eight to year 12), diploma (nursing, teaching, trade certificate, technician certificate, undergraduate diploma), degree (bachelor, postgraduate diploma, masters/doctorate).[31] Physical activity undertaken in the past 7 days was determined using the Active Australia Survey, a validated self-reported questionnaire.[32] Total physical activity was calculated as the sum of the time spent walking (if continuous and >10 minutes), the time spent doing moderate-intensity activities plus double the time spent participating in vigorous physical activity. Total physical activity, (hours per week) >840 min (14 h) for each activity was truncated to 840 min (14 h) in IBM SPSS software (version 22.0, 2013, IBM Corp) to avoid over reporting, in line with the Active Australia Survey Manual.[33]

Statistical analysis

All data were analysed using SPSS 24.0 for Windows (SPSS Inc.) and STATA SE, version 15 (1985-2017; StataCorp). Descriptive statistics (mean values and standard deviations (SD), median and interquartile range (IQR), or numbers and percentages) were calculated to describe participant characteristics. All data were normally distributed as assessed using skewness and kurtosis statistics. Mean daily fruit intake was assessed and presented as percentage of women who achieved the recommended daily serves based on the Australian Dietary Guidelines.[32] Differences between pregnant and breastfeeding characteristics were assessed using the Mann-Whitney U test for categorical variables and the independent sample t-test for continuous variables. Relationships between fruit and vegetable intake and psychological distress were investigated using linear regression adjusted for relevant covariates as determined by previous literature (age, education, physical activity).[34,35] Regression models were adjusted for age and education (Model 1) with further adjustments for physical activity (Model 2). Separate regression analyses were conducted to investigate the association of fruit intake, vegetable intake and also combined fruit and vegetable intake. Model residuals were assessed for normality and heteroscedascity using P-P plots and plots of residuals against fitted values, respectively. $p<0.05$ was considered statistically significant.

Data provided by the Australian Bureau of Statistics was in a Confidentialised Unit Record File (CURF).[31] To ensure an individual person cannot be identified, the Australian Bureau of Statistics removes any information that uniquely identifies an individual, may change a small number of values or remove very unusual records and exclude some data items that were collected. Furthermore, there are restrictions on data and analyses that may be reported in order to maintain confidentiality.

RESULTS

Table 1 shows the demographic characteristics for 166 pregnant and 207 breastfeeding women. Overall, breastfeeding women compared to pregnant women were older and had a lower intake of fruit ($p<0.05$). There were no differences in the number in each education category between the pregnant and breastfeeding women ($p>0.05$). Forty-one percent of pregnant women and 48% of breastfeeding women met the recommended guidelines of 150-300 minutes/week of low to moderate activity.[36] The mean K10 score for both groups was in the 10-15 'little or no psychological distress" range.[23] Sixty-four percent of pregnant women and 52% of breastfeeding women met the daily recommended fruit intake.[32]

Table 2 shows the linear regression models investigating the association between fruit and vegetable intake and psychological distress in pregnant and breastfeeding women separately. In pregnant women, both fruit and vegetable intake were inversely associated with psychological distress in the crude model, but this relationship was no longer present in the adjusted models. Combined fruit and vegetable intake was inversely associated with psychological distress in the crude and fully adjusted models (Table 2). For combined fruit and vegetable intake, results from the fully adjusted model show that one serve/day increase was related with a β -0.37 (95% CI -0.72, -0.02) reduction in psychological distress. In breastfeeding women, there was no evidence of an association between fruit and vegetable intake either individually or combined and psychological distress in crude and adjusted models.

DISCUSSION

Our aim was to determine the association between fruit

Table 1. Characteristics of study participants

Characteristics	Pregnant women (N=166)	Breastfeeding women (N=207)	*p* value†
Age (years)	30.8±5.2	32.1±5.3	0.01
Education, N (%)			0.22
Secondary school/ No formal qualification	40 (24.5)	46 (22.2)	
Diploma/ Certificate/ Trade/ Apprentice	62 (38.0)	67 (32.4)	
University Degree/ Higher University Degree	61 (37.4)	90 (43.5)	
Physical activity (minutes/week), Median [IQR]	100 [210.0]	130.0 [285.0]	0.14
Psychological distress (K10) (mean±SD)	13.7±4.1	14.0±4.2	0.50
Fruit (serves/day) (mean±SD)	2.0±1.0	1.7±1.0	0.01
Vegetables (serves/day) (mean±SD)	2.5±1.2	2.7±1.2	0.13
Fruit and vegetables (serves/day) (mean±SD)	4.5±1.8	4.4±1.6	0.73

IQR Interquartile range.
Values are means±SD, N(%) and medians and interquartile ranges.
†Mann-Whitney U test for categorical variables and the independent sample t-test for continuous variables. $p<0.05$ was considered statistically significant.

Table 2. Associations between fruit and vegetable intake and psychological distress[†] in pregnant and breastfeeding women

	Pregnant women (N=165)		Breastfeeding women (N=207)	
	β (95%CI)	*p* value	β (95%CI)	*p* value
Fruit intake				
Crude	-0.66 (-1.28, -0.05)	0.03	-0.47 (-1.01, 0.08)	0.09
Model 1	-0.45 (-1.06, 0.15)	0.14	-0.42 (-0.96, 0.13)	0.14
Model 2	-0.45 (-1.07, 0.16)	0.14	-0.40 (-0.94, 0.15)	0.15
Vegetable intake				
Crude	-0.53 (-1.04, -0.02)	0.04	-0.29 (-0.73, 0.15)	0.20
Model 1	-0.46 (-0.96, 0.04)	0.07	-0.24 (-0.69, 0.20)	0.28
Model 2	-0.46 (-0.97, 0.04)	0.07	-0.22 (-0.67, 0.23)	0.33
Fruit and vegetable intake				
Crude	-0.47 (-0.82, -0.12)	0.01	-0.31 (-0.63, 0.01)	0.06
Model 1	-0.37 (-0.72, -0.03)	0.04	-0.23 (-0.60, 0.05)	0.10
Model 2	-0.37 (-0.72, -0.02)	0.046	-0.26 (-0.58, 0.07)	0.12

Unstandardised regression coefficients, 95% confidence intervals and p values were calculated by linear regression. Model 1: adjusted for age, education; Model 2: adjusted for age, education, physical activity.
[†]Psychological distress measured with the Kessler Psychological Distress Scale which has a range of 10-50, with higher scores indicating greater psychological distress.[27]
$p<0.05$ was considered statistically significant.

and vegetable intake and psychological distress in a nationally representative sample of Australian pregnant and breastfeeding women. We have reported for the first time that higher levels of combined fruit and vegetable intake were associated with lower levels of psychological distress in pregnant women. However, there was no evidence of an association in breastfeeding women. Our findings in pregnant women accord with a number of large cross-sectional studies internationally. For example, a study conducted in Japan, found that a healthy dietary pattern, characterised by a high intake of vegetables, was associated with lower levels of depression in a large sample of 1744 pregnant women.[20] Furthermore, in a population of 712 pregnant Brazilian women, a diet low in fruit and high in sweets/sugars was associated with a higher prevalence of major depressive disorder.[18] It should be noted, however, that the evidence of this association remains equivocal with an Australian study including 167 pregnant and postpartum women, reporting that a healthy dietary pattern which included fruit and vegetables was not associated with depressive symptoms.[19] Although this study was conducted in Australian pregnant women, it did not undertake the same rigorous sampling methodology employed by the Australian Bureau of Statistics in the Australian NHS to ensure a nationally representative sample. Furthermore, the low sample size and reduced power may have limited the ability to detect an association between dietary patterns and depression.[19] Collectively, the findings from these observational studies suggest that higher fruit and vegetable intake is associated with better mental health in pregnant women and the general population. We also found that a one serve per day increase in fruit and vegetables combined was associated with a 0.4 reduction in psychological distress score in pregnant women. While fruit and vegetable consumption may contribute to small changes in psychological distress in pregnant women, as part of an overall healthy lifestyle including physical activity, which is known to be associated with lower levels of psychological distress,[37] this could lead to improvements in mental health in this population group.

In this study, we found it was the consumption of both fruit and vegetables, rather than fruit or vegetables independently, that was associated with lower levels of psychological distress. This finding has also been reported in a national, population based survey of Canadians (n=296,121), where combined fruit and vegetable intake, but not separate intakes of these foods was associated with lower odds of depression.[22] Further, in a population based survey conducted in Switzerland (n=20,220), participants consuming the recommended quantities of fruit and vegetable had a lower odds of reporting high distress levels compared to those who adhered to only the vegetable or fruit recommendations.[21] However, these findings are not supported by an Australian study (n=60,404) where fruit and vegetable intake, measured separately or combined, was associated with lower levels of psychological distress in cross sectional analyses.[25] Overall, these findings suggest that greater consumption of fruit and vegetables combined contributes to better mental health.

An important finding from this study is that there was no evidence of an association between fruit, vegetable, or fruit and vegetable intake combined and levels of psychological distress in breastfeeding women. To the best of our knowledge, we are the first study to report this in this specific group as compared to postpartum women in general. One possible explanation may relate to evidence that postpartum depression was associated with shorter breastfeeding duration,[38] so it is possible that postpartum women with depression were not breastfeeding and were not included in the analysis and in turn, this limited our ability to detect an association between fruit and vegetable consumption and psychological distress. Further, it is well established that higher levels of maternal education are associated with breastfeeding maintenance.[39] However, we found no difference in education levels between pregnant and breastfeeding women and adjusting for education in the regression model had no effect on the asso-

ciation between fruit and vegetable consumption and psychological distress. The established benefits of fruit and vegetable consumption for all cause mortality and cardiovascular mortality[16,40] confirm the importance of their inclusion in all diets.

Several mechanisms may underlie the relationship between fruit and vegetable intake and better mental health in pregnant women observed in the current study. Increased inflammation, via higher levels of proinflammatory cytokines and oxidative stress, have been linked to the development of depression in adults.[41] Diets high in fruits and vegetables have been inversely correlated with serum levels of inflammatory markers.[42] In the Women's Health Initiative Observational Study, higher intake of magnesium, which is found in vegetables, was found to be inversely associated with a number of inflammatory biomarkers including HS-CRP, IL-6 and TNF-α-R2.[42] Further, the role of the gut microbiome in the development of chronic disease is a growing area of interest.[43,44] The gut microbiome have been implicated in neurobiological pathways related to mental health, including brain-derived neurotrophic factor, a growth hormone for brain cells, inflammation, and the hypothalamic-pituitary-adrenal stress response.[43] Diets high in fruits and vegetables, such as the Mediterranean diet, are known to increase beneficial gut microbiota including *bifidobacteria*, *lactobacill*i and *prevotella,* which improved inflammation.[44]

The strengths of the study include the robust data collection methods utilised by trained staff of the Australian Bureau of Statistics. The data collected has broad geographic representation, so the findings are likely to be generalisable to the larger population of pregnant and breastfeeding women in Australia. Further, fruit and vegetable consumption was assessed with short validated questions typically used in health monitoring surveys,[24-26] however no time frame was given for consumption, although it is likely respondents may have reported their most recent intake. A number of study limitations must be considered when interpreting the findings. The cross sectional design of the study prevents the detection of causal relationships between fruit and vegetable intake and psychological distress levels. The data are largely based on self-report and may be subject to recall and social desirability bias. Further, levels of psychological distress were reported during the previous four weeks, however the time frame for fruit and vegetable consumption was not defined, this may have implications for detecting an association between fruit and vegetable intake and psychological distress. A further limitation was the absence of potentially important co-variate data in the NHS. In the regression model, we were only able to adjust for age, education (indicator of socioeconomic position, consistent with previous studies)[30] and physical activity, so it is possible residual confounding remained as a result of unmeasured covariates (such as energy intake, weight, smoking, sleep) that are known to be associated with mental health outcomes in women.[45] We also have no data on the weeks of pregnancy or breastfeeding. Despite these limitations inherent in the Australian NHS, these existing data provide a unique opportunity to explore fruit and vegetable consumption and associations with levels of distress in Australian pregnant and breastfeeding women.

This study has shown that in a nationally representative sample of Australian pregnant women, a higher intake of combined fruit and vegetables was associated with lower levels of psychological distress. However, there was no evidence of an association in breastfeeding women. Our findings from this cross sectional analysis further endorse the need for longitudinal and intervention studies to determine causality. These findings also provide support for the advice to consume fruit and vegetables promoted in Australian and international dietary guidelines for all postpartum women including breastfeeding women, given the evidence for its protective effect against many chronic diseases.

AUTHOR DISCLOSURES

The authors declare no conflict of interest or funding disclosures.

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