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The Association between Diet Quality and Mental Health during the Perinatal Period: A Systematic Review

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Abstract

Background: While maternal nutrition during pregnancy is known to play a critical role in the health of both mother and offspring, the magnitude of this association has only recently been realized. Novel, epigenetic data suggest that maternal dietary intake has permanent phenotypic consequences for offspring, highlighting the potency of antenatal diet. To date, the relationship between poor antenatal diet and maternal mental health specifically, remains poorly understood. Therefore, we aimed to systematically review evidence that has examined associations between antenatal diet quality and the experience of depressive, anxiety and stress symptoms during the perinatal period.

Methods: A search for peer-reviewed papers was conducted using Medline Complete, PsycINFO, CINAHL, Academic Search Premiere and Psychology and Behavioral Science Collection.

Results: Nine studies (cohort=4, cross-sectional=5) published between 2005 and 2013 were eligible for inclusion in this review. A synthesis of findings revealed positive associations between poor quality and unhealthy diets and antenatal depressive and stress symptoms. Healthy diets were inversely associated with antenatal depressive and anxiety symptoms. Antenatal anxiety and postnatal depressive symptoms demonstrated inconsistent results.

Conclusions: Given the paucity of research examining diet quality and mental health in women during the perinatal period, further sufficiently powered studies are urgently required to examine this association.

Keywords: maternal diet, mental health, perinatal, pregnancy, postnatal, depression, anxiety, stress
Introduction

The perinatal period, defined as pregnancy and one year postpartum, represents a vulnerable time for women as they undergo physical, physiological, psychological and social changes [1]. During this time women are also at increased risk of experiencing serious mental health problems that can impact the health and wellbeing of both mother and infant [2-5]. Impaired maternal mood has been associated with an increased risk of pre-eclampsia, birth complications, low birth weight baby and poor infant growth and development [4, 6-8]. Moreover, experiencing distress during pregnancy and motherhood can negatively impact the early prenatal environment and mother-child interactions that are important factors in infant cognitive and emotional development [9-13].

The prevalence of poor maternal mental health is an increasing public health concern worldwide. Ten to twenty percent of women experience depression during the perinatal period [2, 3]. While, compared with perinatal depression, the prevalence of perinatal anxiety has been under-investigated, research suggests that symptoms of anxiety and anxiety disorders may be as common those of depression and depressive disorders during the perinatal period [14]. The Maternal Health Study conducted in Australia found that 7.3% of women reported intense anxiety or panic attacks in early pregnancy, increasing up to 15.7% of women during the first three months postpartum [14]. Psychosocial stressors prevalent during pregnancy, including financial concerns, lack of social support and drug or alcohol abuse further increase the risk of perinatal distress [15]. Consequently, it is imperative to identify modifiable lifestyle factors that contribute to the development of mental health problems in mothers (and potentially their offspring) and develop appropriate interventions for at-risk populations.
The relationship between diet and mental illness has garnered much attention over the past five years [16-18]. Previous research in women during pregnancy and postpartum has focused on the intake of individual micronutrients and vitamins with inverse associations observed between the intake of zinc, iron, vitamin D, selenium, omega-3 fatty acids, folic acid and depressive symptoms [19-24]. However, not all studies have supported an association between nutrients and depressive symptoms [25-28].

Given the complex interaction among the many micronutrients, minerals and vitamins that make up habitual diet, studying individual nutrients in isolation may provide an incomplete analysis of the relationship between diet and mental health [29]. Quirk et al. in 2012 [17] were the first to systematically review the association between diet quality, dietary patterns and depression in general adult populations. The authors concluded that there was limited evidence to support an association between traditional healthy, Mediterranean and Norwegian diets and decreased depressive symptoms, and they called for stronger and more consistent evidence in this area [17]. A subsequent systematic review and meta-analysis that incorporated the increasing number of studies in this area revealed that a healthy diet was significantly associated with a reduced likelihood of depressive symptoms [16]. This study reported a positive association between unhealthy Western diets and the odds of depressive symptoms; however, this association was not significant, potentially due to the relative lack of available studies on this topic [16]. While fewer studies have explored the association between diet quality and anxiety and stress, there is evidence to suggest that the mechanism underlying the association between diet quality and mental illness is not limited to depressive symptoms [29].

This paper is the first to present the findings of a systematic review of published studies that have examined the relationship between antenatal diet quality and mental health.
outcomes in the perinatal period. Explicating this relationship during this unique period is of increasing importance. Firstly, pregnancy is a period during which nutritional requirements and energy needs are increased and are important to the health outcomes of both mother and baby [30]. Secondly, numerous factors during this period influence a woman’s dietary choices and quality, including nausea, fatigue and food cravings [31]. Thirdly, pregnancy is a time during which most women are engaged with health services, thus presenting opportunity for intervention. Finally, a majority of women are currently failing to meet nutritionally recommended standards when planning to become pregnant or during pregnancy [30, 31]. There is thus a need to further investigate the possible implications of dietary behaviors on mental health during this critical period.

This review subsequently addressed the following questions:

1. What is the association between diet quality during pregnancy and antenatal depression, anxiety and/or stress?

2. What is the association between diet quality during pregnancy and postnatal depression, anxiety and/or stress?

**Method**

**Eligibility Criteria**

Studies were eligible for inclusion if they examined the association between diet quality during pregnancy and mental health outcomes, defined as either depression or depressive symptoms, anxiety and/or stress during pregnancy and/or postpartum, as assessed by self-report inventories and/or diagnostically examined. Diet quality was defined as the quality of one’s typical food intake over a specified time period in comparison to healthy eating guidelines or a dietary pattern (e.g., traditional diet or Western diet) [17]. Studies were
excluded if they: (1) examined only individual nutrients, micronutrients or single food groups; (2) measured diet during postpartum period only; (3) investigated diet in relation to malnutrition or food insecurity; (4) investigated diet in relation to disordered eating or gestational diabetes; (5) included only a few questions on diet as part of a health promoting lifestyle questionnaire; (6) utilized animal models; (7) were pilot studies; or (8) were qualitative studies.

**Information Sources and Study Selection**

Articles were sourced from five databases: Medline Complete, PsycINFO, CINAHL, Academic Search Premiere and Psychology and Behavioral Science Collection. The search was restricted to English, peer reviewed papers with no date restriction. The search strategy was confirmed by two authors (RB and HS). A full search strategy for the PsycINFO database can be found in Supplementary File 1.

After removing duplicates, remaining papers were screened through title and abstract by one author (RB) in consultation with another author (HS). Studies that required further examination were reviewed full-text by two authors (RB and HS) to determine their eligibility for inclusion. Where areas of uncertainty occurred co-authors were consulted. In addition, reference lists of eligible papers and similar reviews were scanned for further studies. This review adhered to PRISMA guidelines [32].

**Data Collection and Methodological Quality**

The following data were extracted from eligible papers and entered into an extraction table: participant characteristics, sample size, dietary assessments (measures, time of completion and summary of diet quality), mental health assessments (measures, time of completion and cut-off scores), covariates, and statistical findings.
In reviewing the methodological quality of eligible studies, 12 criteria covering five aspects were considered (Table 1). An overall quality score was given by scoring each study on each criterion, 1 if criteria were met and 0 if criteria were not met or unclear. A maximum score for cross-sectional studies was 8 and for cohort studies 12. Final scores were converted into percentages out of 100 and presented in Supplementary File 2. This method was adapted from Lievense et al [33] and Quirk et al [17]. Based on these criteria, studies with a methodological quality score below 50% were not included in the synthesis of results; however, the characteristics of these studies are presented in the extraction table (Supplementary File 2).

Results

Study Selection

The final search of databases occurred on the 11th of December 2013 and generated 5653 articles. Reasons for exclusion of articles read in full have been provided in Supplementary File 3. Nine articles were eligible for this review. Figure 1 outlines the flow of studies meeting criteria for inclusion.

Methodological quality

Methodological quality scores of eligible studies ranged from 25% [34] to 88% [35-38] in cross-sectional studies and from 67% [13] to 92% [39, 40] in cohort studies (Supplementary File 2). After a series of consultations with two of the co-authors (HS, AO) the findings of one cross-sectional study [34] were excluded from a synthesis of results due to a score falling below 50% using Lievense et al [33] and Quirk et al [17] criteria. Thus the results presented below are based on the eight remaining studies.

Study Characteristics
A summary of characteristics, including sample size and measures of diet and mental health assessments used are outlined in Supplementary File 2. Of the eight reviewed articles, four used cross-sectional designs [35-38] and four used cohort designs [13, 39, 40, 41]. Three studies were conducted in the US [35-37], two in the UK [13, 38], two in Japan [40, 41] and one in Greece [39].

Sample sizes ranged from 50 [36] to 9530 women [38] in cross-sectional designs and from 529 [39] to 6979 women [13] in cohort designs (total n=18205). Two studies used the same sample from the Osaka Maternal and Child Health Study (OMCHS) in Japan [40, 41], two studies used different subsamples from the AVON Longitudinal Study of Parents and Children (ALSPAC) in the UK [13, 38], and one study reported on the mother-child ‘Rhea’ study in Greece [39]. Three cross-sectional studies included specified populations: low-income women [35, 36] and well-educated, middle class women [37]. Length of follow up assessments in cohort studies ranged from 8 weeks to 47 months postpartum.

**Dietary Assessment**

A variety of tools were used to measure habitual dietary intake, defined as the average frequency and/or portion size of food items consumed over a selected period. Four studies included a self-administered Food Frequency Questionnaire (FFQ) [13, 37, 38, 39]: one using a FFQ validated (by the authors) against 24 hour dietary recalls using a subsample of the same cohort [39], one using an FFQ validated previously against diet records [37] and two using an independently constructed non-validated version of an FFQ [13, 38]. Two studies used a self-administered Diet History Questionnaire that had been previously validated against serum biomarkers and diet records [40, 41]. Two studies used a systematic 24-hour dietary recall collected over the phone using the Nutrition Data System for Research software (no information about validity of this software was included) [35, 36].
Methods for summarizing diet quality are displayed in Supplementary File 2. Diet quality scores were estimated in three studies: two using the Dietary Quality Index-Pregnancy [35, 36], and one assessing Dietary Glycemic Index/Load using the Standard Tables of Food Composition in Japan [41]. The remaining studies delineated diet patterns using factor analysis and other statistical techniques. Healthy or health-conscious patterns consisting of vegetables, fruits, wholegrain and seafood were found in four studies [13, 38, 39, 40]. A traditional healthy diet consisting of vegetables, meat and poultry was also explored in one study [38]. A traditional Japanese diet was examined in one study [40]. Unhealthy diets including processed diets, confectionary diets and Western diets consisting of fast foods, sugars, sweets, oils, beverages and sauces were investigated in five studies [13, 37, 38, 39, 40]. A vegetarian style diet was explored in one study [38].

**Mental Health Assessment**

Assessment of mental health varied across studies (Supplementary File 2). Antenatal depressive symptoms were assessed in three studies [13, 35, 36] using the Edinburgh Postnatal Depression scale (EPDS), a validated self-rating scale used in clinical and research settings to detect depressive symptoms in both pregnancy and postpartum periods. Scores calculated from this scale can be used as a continuous variable with greater scores indicating greater depressive symptoms or categorized into levels of depressive symptoms using validated cut-off points. One study analyzed depressive symptoms as a continuous variable [13] and two studies used a cut-off (≥10) to identify possible depression [35, 36]. Postnatal depressive symptoms were assessed in four studies using the EPDS [13, 39, 40, 41]: one analyzing depressive symptoms using the continuous variable [13], two using a cut-off (≥9) to detect depression [40, 41] and one using both the continuous variable and cut-off (≥13) to indicate high levels of depressive symptoms [39].
Two studies assessed anxiety during pregnancy, one using the widely validated State and Trait Anxiety Inventory (STAI) with higher scores reflecting higher levels of anxiety [37] and the other the Crown-Crisp Experiential Index (CCEI; validated against the STAI and clinical diagnoses) using a cut-off (≥9) to categorize higher levels of anxiety [38]. Three studies assessed stress during pregnancy using the Prenatal Psychosocial Profile-Stress Subscale [35, 36] (validated against measures of self esteem and social support) and the Perceived Stress Scale (validated against self report and behavioral outcomes) [37]. In both scales higher scores reflected higher levels of stress.

**Covariates**

A range of potential covariates were included across studies (Supplementary File 2). Parity, education and income were included in a majority of the studies. One study did not control for age [13]. Social factors including housing conditions and social support were included in four studies [13, 35, 38, 39]. Two studies controlled for Body Mass Index [37, 39] and three controlled for total energy intake [37, 38, 39]. One study included a history of depression in previous pregnancies [39].

**Findings of the Studies (Table 2)**

**Antenatal depression. Cohort.** In the ALSPAC study, both an unhealthy diet and decreased healthy diet at 32 weeks gestation were independently and significantly associated with increased antenatal depressive symptoms at 32 weeks gestation [13].

**Cross-sectional.** Two studies demonstrated a significant inverse association between diet quality and antenatal depressive symptoms during the first trimester of pregnancy [35, 36].

**Antenatal anxiety. Cross-sectional.** Findings supported significantly higher anxiety in association with diets high in fats, oils, sweets and snacks [37] and a vegetarian style diet
[38] at 28 and 32 weeks gestation respectively. Conversely, decreased odds of high anxiety symptoms were associated significantly with health conscious and traditional diets at 32 weeks gestation [38]. One study found no relationship between anxiety and confectionary or processed diets at 32 weeks gestation [38].

**Antenatal stress. Cross-sectional.** Three studies revealed that stress was significantly associated with decreased diet quality during the first trimester [35, 36] and diets high in fats, oils, sweets and snacks at 28 weeks gestation [37].

**Postnatal depression. Cohort.** In the ALSPAC study, a healthy diet at 32 weeks gestation was significantly associated with decreased depressive symptoms between 8 weeks and 33 months postpartum, while an unhealthy diet at 32 weeks gestation was significantly associated with increased depressive symptoms [13]. Similarly, the ‘Rhea’ cohort in Greece demonstrated a significant decreased risk of postnatal depressive symptoms between 8 and 10 weeks postpartum in association with a healthy diet consumed during 14 and 18 weeks gestation [39]. In contrast, no relationship was found between a healthy diet during pregnancy and subsequent depressive symptoms between 2 and 9 months postpartum in the OMCHS cohort [40].

Among other pregnancy diets, both the ‘Rhea’ and OMCHS cohort studies found no evidence of an association between Western diets and postnatal depressive symptoms between 8 and 10 weeks postpartum [39] and 2 and 9 months postpartum respectively [40]. Similarly, no evidence was found linking a traditional Japanese diet [40] or diets high in Glycemic Index/Load with postnatal depressive symptoms between 2 and 9 months postpartum in the OMCHS cohort study [41].
Discussion

The aim of this study was to investigate the association between women’s diet quality during pregnancy and the experience of depression, anxiety and stress during the perinatal period. This is a relatively new area of investigation, as evidenced by the small number of studies meeting inclusion criteria. Nonetheless, the existing evidence base showed limited evidence in support of a positive association between poor diet quality and antenatal depressive and stress symptoms and an inverse association between healthy diets and antenatal depressive and anxiety symptoms. We also observed conflicting evidence for the associations between poor quality diets and antenatal anxiety and healthy diets and postnatal depressive symptoms.

When investigating reasons for the significant findings linking poor diet quality with mental health problems during pregnancy, it is possible that women experiencing depressive, anxiety or stress symptoms may eat poorly as a self-coping mechanism. Moreover, they may have reduced motivation and drive to maintain a healthy diet over a prolonged period of nine months. Indeed, antenatal depressive symptoms have been linked to poor self-care and a decrease in seeking proper medical care [4]. It is equally plausible that diet during pregnancy may act as a risk factor for developing mental illness. As women’s bodies undergo significant physical and physiological changes, they are more susceptible to nutritional deficiencies resulting from poor quality diets, which may in turn directly influence biochemical systems that underlie the experience of depression and stress [3]. Conclusive evidence of the direction of causality could not be reported in this review; clearly further research is needed to provide this evidence.
We also recognize that a number of other factors may contribute to a multifaceted relationship between diet and mental illness during pregnancy. Fowles et al [35] identify social support, for example, as being related to both diet quality and distress in their model of diet quality predictors in low-income pregnant women. Additionally, women coming from low-income backgrounds may have less control over their diet and limited access to health care during pregnancy compared with women from higher socioeconomic backgrounds, putting them at an increased risk for developing poor mental health outcomes [35, 36]. Psychiatric history is also likely an important effect modifier in the relationship between diet and mental health in pregnancy. However, as only one study controlled for depression before pregnancy [39], we can only speculate.

Possible reasons for the conflicting findings among studies include the heterogeneity between sampling characteristics and the differences in measures and timing of assessments. A majority of studies used the EPDS to measure depressive symptoms, however, there were differences regarding the use of this scale to form a continuous or categorical variable (with varying cut-off scores) for depressive symptoms, with only one study reporting both [39]. There was also large variation in the use of statistical techniques and level of detail reported (a number of studies lacked sufficient statistical reporting including standards errors or 95% confidence intervals) as evidenced in Table 2. This limited our ability to conduct a true meta-analysis of findings. Other reviews that have investigated the association between diet quality and mental health in adult populations have similarly highlighted and discussed these limitations [16, 17].

There were a number of other limitations applicable to the studies included in this review. A majority of studies relied on self-administered questionnaires of diet quality
and mental health. Although clinician-based diagnoses or food diaries that record food consumption daily throughout pregnancy would be optimal to reduce bias, they are less practical when conducting studies that require a large sample size. The studies in this review were also restricted to both cross-sectional designs and cohort studies that measured dietary intake only once during pregnancy. However, diet has been shown to change across pregnancy [42]. The timing of assessments and use of numerous measurement points across pregnancy are likely to have an impact on the quality of findings [5]. It is also important to note that the use of observational and cross-sectional designs makes it difficult to draw conclusions about the direction of association. It is probable that a bi-directional relationship exists, with diet quality and mental health influencing each other.

**Implications for future research**

There is emerging evidence to suggest that diet plays a significant role in maternal mental health during the perinatal period - pregnancy in particular - however little is known about how this relationship operates. Currently there are only limited studies that focus on this population in isolation, with the few studies reporting on this association demonstrating less than optimal methodological quality. Examining diet in the context of the perinatal period provides us with a unique opportunity to explore possible interventions and modifiable health behaviors that can alter mental health outcomes alternative to the use of medications, an important consideration amongst childbearing women. Importantly, with recent studies highlighting the role of early environmental influences, particularly during gestation, on the subsequent mental health outcomes of offspring, early antenatal assessment and intervention becomes pertinent [7].
Following recommendations put forward by Quirk et al [17] and Lai et al [16] we agree that there is a greater need for high quality studies that contain standard definitions and measurements of diet quality and patterns. However unique to this cohort is the need for well-designed longitudinal studies that measure diet quality at more than one time point during pregnancy, up until a few years postpartum. Dietary intervention studies are also recommended to explicate causal relationships. Finally, there remains a need for more studies to examine multiple mental health outcomes, beyond depression. This review demonstrated preliminary evidence in regards to anxiety and stress in association with the diet quality of women during pregnancy. We found no studies that examined anxiety or stress during the postpartum period. Symptoms of anxiety and stress are prevalent during the postpartum period and can be masked by or co-exist with symptoms of depression and it is important that future studies address this [14, 43].

Conclusions

This review is the first to systematically examine associations between diet quality and mental health during the perinatal period. Given the established impact that antenatal diet and mental health outcomes have on both mother and baby and the emerging evidence supporting an association between antenatal diet and maternal mental health outcomes, it is of major public health significance to continue research in this area. Future studies that explore dietary intake at more than one time point during pregnancy and examine the potential of maternal dietary modification on mental health outcomes of pregnant women are recommended.

Competing interests
AO and FNJ have received funding from Meat and Livestock Australia.

**Acknowledgement**

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43. Miller RL, Pallant JF, Negri LM: Anxiety and stress in the postpartum: is there more to postnatal distress than depression? *BMC Psychiatry* 2006, **6**:12-12.
Table 1
Criteria list for assessing methodological quality of studies taken from Lievense et al [33] and Quirk et al [17]

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Study design</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Study population</strong></td>
<td></td>
</tr>
<tr>
<td>1. Selection at uniform point</td>
<td>Cohort/Cross-Sectional</td>
</tr>
<tr>
<td>2. Participation rate &gt;80%</td>
<td>Cohort</td>
</tr>
<tr>
<td>3. Sufficient description of baseline characteristics</td>
<td>Cohort/Cross-Sectional</td>
</tr>
<tr>
<td><strong>Assessment of diet quality</strong></td>
<td></td>
</tr>
<tr>
<td>4. Assessed according to validated measure</td>
<td>Cohort/Cross-Sectional</td>
</tr>
<tr>
<td><strong>Assessment of mental health outcome</strong></td>
<td></td>
</tr>
<tr>
<td>5. Assessed identically in studied populations</td>
<td>Cohort/Cross-Sectional</td>
</tr>
<tr>
<td>6. Outcome reproducibly</td>
<td>Cohort/Cross-Sectional</td>
</tr>
<tr>
<td>7. Assessed according to validated measures</td>
<td>Cohort/Cross-Sectional</td>
</tr>
<tr>
<td><strong>Study design</strong></td>
<td></td>
</tr>
<tr>
<td>8. Prospective design used</td>
<td>Cohort</td>
</tr>
<tr>
<td>9. Follow up time ≥12 months</td>
<td>Cohort</td>
</tr>
<tr>
<td>10. Withdrawals &lt;20%</td>
<td>Cohort</td>
</tr>
<tr>
<td><strong>Analysis and data presentation</strong></td>
<td></td>
</tr>
<tr>
<td>11. Appropriate analysis technique used</td>
<td>Cohort/Cross-Sectional</td>
</tr>
<tr>
<td>12. Adjusted for at least age</td>
<td>Cohort/Cross-Sectional</td>
</tr>
</tbody>
</table>
Figure 1. PRISMA flowchart outlining systematic search

Records identified through database search
\( (n=5653) \)

Records after duplicates removed
\( (n=4013) \)

Records screened via title and abstract
\( (n=4013) \)

Full-Text articles assessed for eligibility
\( (n=63) \)

Studies included in systematic review
\( (n=9) \)

Records excluded
\( (n=3950) \)

Full-text articles excluded with reason
\( (n=54) \)
- Eating disorders=2
- Micronutrients or macronutrients=6
- Single food group=1
- Review/editorial=9
- Pilot study=3
- No measure of diet quality=15
- No measure of mental health outcomes=3
- Diet relating to health promoting behaviors=3
- Food insecurity=2
- Not in English=1
- No association between diet and mental health reported=2
- Diet measured in postpartum only=2
- Not limited to pregnancy=2
- Project plan=1
- Qualitative study=2
Table 2  
*Summaries of associations between diet quality and mental health outcomes*

<table>
<thead>
<tr>
<th>Study</th>
<th>Statistical test used</th>
<th>Statistical finding</th>
<th>p*</th>
<th>Associated variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barker et al., 2013 [13]</td>
<td>Path Analysis</td>
<td>$b = 0.10$</td>
<td>&lt;0.05</td>
<td>Antenatal depressive symptoms and an unhealthy diet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$b = 0.10$</td>
<td>&lt;0.05</td>
<td>An unhealthy diet and postnatal depressive symptoms</td>
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<td></td>
<td>$b = -0.06$</td>
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<td>Antenatal depressive symptoms and a healthy diet</td>
</tr>
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<td></td>
<td>$b = -0.03$</td>
<td>&lt;0.05</td>
<td>A healthy diet and postnatal depressive symptoms</td>
</tr>
<tr>
<td>Chatzi et al., 2011 [39]</td>
<td>Multivariable-log binomial regression</td>
<td>$Adjusted \text{RR}^{d} = -1.75$ (3.22, -0.28)</td>
<td>0.02</td>
<td>A health conscious diet and postnatal depressive symptoms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$Adjusted \text{RR} = 1.32$ (-0.19, 2.76)</td>
<td>0.07</td>
<td>A Western diet and postnatal depressive symptoms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$Adjusted \text{RR} = 0.51$ (0.25, 1.05)</td>
<td>0.04</td>
<td>A health conscious diet and high levels of postnatal depressive symptoms (EPDS$^{d} \geq 13$)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$Adjusted \text{RR} = 1.14$ (0.58, 2.26)</td>
<td>0.70</td>
<td>A Western diet and high levels of postnatal depressive symptoms (EPDS$^{d} \geq 13$)</td>
</tr>
<tr>
<td>Fowles, Bryant et al., 2011 [35]</td>
<td>Regression analysis</td>
<td>$\beta = -0.21$,$t(5) = -2.00$</td>
<td>0.05</td>
<td>Distress (an index of depression and stress) during pregnancy and Diet Quality Index scores</td>
</tr>
<tr>
<td>Fowles, Timmerman et al., 2011 [36]</td>
<td>Correlations</td>
<td>$r(48) = -0.62$</td>
<td>0.001</td>
<td>Antenatal depressive symptoms and Diet Quality Index Scores</td>
</tr>
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<td></td>
<td></td>
<td>$r(48) = -0.50$</td>
<td>0.007</td>
<td>Antenatal stress and Diet Quality Index Scores</td>
</tr>
<tr>
<td>Hurley et al., 2005 [37]</td>
<td>Pearson correlations</td>
<td>$r(132) = 0.22$</td>
<td>&lt;0.05</td>
<td>A diet high in fats, oil, sweets and snacks and antenatal anxiety</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$r(132) = 0.18$</td>
<td>&lt;0.05</td>
<td>A diet high in fats, oil, sweets and snacks and antenatal stress</td>
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<tr>
<td>Authors</td>
<td>Type</td>
<td>Model</td>
<td>Adjusted $OR^c$</td>
<td>Adjusted $OR^{b}$</td>
</tr>
<tr>
<td>-----------------------</td>
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</tr>
<tr>
<td>Murakami et al., 2008</td>
<td>Logistic regression</td>
<td>$Adjusted OR^c=0.72$ (0.41, 1.26$^b$)</td>
<td>0.18</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$Adjusted OR=0.63$ (0.31, 1.31$^b$)</td>
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<td></td>
</tr>
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<td>Okubo et al., 2011</td>
<td>Logistic regression</td>
<td>$Adjusted OR=0.94$ (0.52, 1.69$^b$)</td>
<td>0.72</td>
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<td></td>
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<td>$Adjusted OR=0.73$ (0.42, 1.24$^b$)</td>
<td>0.36</td>
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<tr>
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<td></td>
<td>$Adjusted OR=0.96$ (0.56, 1.64$^b$)</td>
<td>0.59</td>
<td></td>
</tr>
<tr>
<td>Jdos Vaz et al., 2013</td>
<td>Logistic regression</td>
<td>$Adjusted OR=0.77$ (0.65, 0.93$^b$)</td>
<td>$&lt;0.01$</td>
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<td>$Adjusted OR=0.84$ (0.73, 0.97$^b$)</td>
<td>$0.02$</td>
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<td>$Adjusted OR=1.03$ (0.88, 1.21$^b$)</td>
<td>0.63</td>
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<td>$Adjusted OR=1.16$ (0.99, 1.37$^b$)</td>
<td>0.06</td>
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<td>$Adjusted OR=1.25$ (1.08, 1.44$^b$)</td>
<td>$&lt;0.01$</td>
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</tr>
</tbody>
</table>

*Significant $p$ values at 0.05 and 0.01 levels are in boldface
$^a$RR=relative risk, $^b$95% confidence Interval, $^c$OR=Odds Ratio
$^d$EPDS= Edinburgh Postnatal Depression Scale, $^e$CCEI=Crown-Crisp Experiential Index