Antenatal depression symptoms during pregnancy: Evidence from *Growing Up in New Zealand*

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RUNNING HEAD: Antenatal depression

ABSTRACT

Background: Depression during pregnancy has significant implications for pregnancy outcomes and maternal and child health. There is a need to identify which family, physical and mental health factors are associated with depression during pregnancy.

Methods: An ethnically and socioeconomically diverse sample of 5,664 pregnant women living in New Zealand completed a face-to-face interview during the third trimester. Antenatal depression (AD) symptoms were assessed using the Edinburgh Postnatal Depression Scale (EPDS). Maternal demographic, physical and mental health, and family and relationship characteristics were measured. The association between symptoms of AD and maternal characteristics was determined using multiple logistic regression.

Results: 11.9% of the participating women had EPDS scores (13+) that indicated probable AD. When considering sociodemographic predictors of AD symptoms, we found that women from non-European ethnicities, specifically Pacific Islander, Asian and other, were more likely to suffer from AD symptoms. Greater perceived stress during pregnancy and a diagnosis of anxiety both before and during pregnancy were also associated with greater odds of having AD according to the EPDS.

Limitations: The women were in their third trimester of pregnancy at the interview. Therefore, we cannot discount the possibility of recall bias for questions relating to pre-pregnancy status or early-pregnancy behaviours.

Conclusions: AD is prevalent amongst New Zealand women. Ethnicity, perceived stress and anxiety are particularly associated with a greater likelihood of depression during pregnancy. Further attention to supporting maternal mental health status in the antenatal period is required.

Keywords: Depression; Antenatal; Prenatal; Perceived Stress; Wellness; Longitudinal

Abbreviations: Antenatal depression **(**AD); Body mass index (BMI); confidence interval (CI); Edinburgh Postnatal Depression Scale (EPDS); EPDS-defined antenatal depression (EPDS-AD), Family Adaptation and Cohesion Scales (FACES III); Perceived Stress Scale (PSS); Odds Ratios (OR)

INTRODUCTION

Depression during pregnancy has adverse effects on maternal health and pregnancy outcomes. Maternal complications of pregnancy associated with depression include inadequate weight gain, underutilisation of prenatal care, continuation of smoking, and premature delivery (Goedhart et al., 2010). Depression during pregnancy is a risk factor for postnatal depression (Cankorur, Abas, Berksun, & Stewart, 2015; Evans et al., 2001; Mallikarjun & Oyebode, 2005).

Depression during the antenatal period is also an important determinant of child health. Poor mental health during pregnancy is associated with intrauterine growth retardation, lower Apgar scores, smaller head circumference, and increased risk of infant mortality (Goedhart et al., 2010). It decreases the likelihood of breastfeeding initiation (Grigoriadis et al., 2013).

The prevalence of depression during pregnancy has been estimated at 7%, 14%, and 12% for first, second, and third trimesters, respectively (systematic review by Bennett et al., 2004). Despite these high rates, depression during pregnancy has received much less attention than postnatal depression, in terms of research, media and health care community interest (Bowen & Muhajarine, 2006).

Recent interest in antenatal depression (AD) has been kindled by research into “fetal programming” (Ponder et al., 2011). Multidisciplinary studies show that a mother's psychological state while pregnant has a strong and long-lasting impact on her child's subsequent development and health. O'Donnell, O’Connor and Glover (2009) concluded a review of the field by stating: “the evidence for an association between maternal stress, depression or anxiety in pregnancy and an adverse neurodevelopmental outcome for the child is now substantial” (p. 290).

Antenatal depression

Antenatal depression, anxiety and stress are frequently co-morbid (Lancaster et al., 2010; Poudevignel & O'Connor, 2006) and can negatively impact the intrauterine environment. For example, stress-induced activation of the sympathetic nervous system (de Bruijn et al., 2009) can increase uterine artery resistance, reducing blood flow to the fetus and altering brain structure and function (Teixeira et al., 1999; Welberg & Seckl, 2001). Antenatal depression has been linked to delayed infant motor development (Huizink et al., 2003) as well as childhood (e.g.,Talge et al., 2007) and adolescent (Pawlby et al., 2009) behavioral and emotional problems. These effects are thought to be via the neuroendocrine effects of maternal depression, anxiety and stress (Field et al., 2003; O'Donnell et al., 2009).

In a systematic review of AD risk factors, Lancaster et al. (2010) found that women with a history of depression, who had experienced domestic violence, had an unintended pregnancy, lower income, or were unemployed, were more likely to experience AD. In contrast, women with more social support and positive health related behaviors, such as reducing alcohol consumption and cigarette smoking, and maintaining a reasonable level of physical exercise, were less likely to develop AD (e.g., Goedhart et al., 2009; Poudevignel & O'Connor, 2006; Odendaal et al., 2008). Intimate partner support also protects against AD (Lancaster et al., 2010).

Our aim in this study was to identify maternal characteristics associated with AD in a socioeconomically and ethnically diverse cohort. We anticipated that identification of such factors would increase the capacity for health care providers to identify and thus treat pregnant women with depression. By conducting this study within a cohort of pregnant women whose children would form a new longitudinal study, we also saw the careful description of maternal depression at baseline to be an essential element of any subsequent life-course assessment of the determinants of child health.

METHODS

Participant and General Procedure

We completed our study of AD symptoms, risk and protective factors in a socioeconomically and ethnically diverse cohort of 5,664 pregnant women who were participating in the *Growing Up in New Zealand* longitudinal study (Morton et al., 2012).

The *Growing Up in New Zealand* cohort of pregnant women was recruited to provide information that is broadly generalisable to all current NZ births (Morton et al., 2012). The women had a due date between 25th April 2009 and 25th March 2010 and lived in the geographical area where about one third of the NZ population lives, covered by three contiguous District Health Board regions (Morton et al., 2013). There were no other inclusion or exclusion criteria (Morton et al., 2013). Ethical approval was obtained from the Ministry of Health Northern Y Regional Ethics Committee. Written informed consent was obtained from all participating women. Detailed descriptions of cohort study design and sample recruitment have been published previously (Morton et al., 2012, Morton et al., 2013).

Enrolled women were comparable to the most recent NZ national birth statistics in relation to maternal age, ethnicity, parity, and indicators of socioeconomic position (Morton et al., 2014). *Growing Up in New Zealand* is a longitudinal study with data collection waves focusing on six inter-connected domains of influence in child development: health and wellbeing; psychological and cognitive development; education; family and whānau (extended family); culture and identity; and neighbourhoods and the societal context.

A face-to-face computer-assisted interview was completed at participants' homes during the third antenatal trimester with 5,664 pregnant women (83% of the 6,822 women enrolled into

Growing Up in New Zealand). The remainder (*n*=1,158) completed antenatal interviews retrospectively, after their babies had been born, and were consequently excluded from the analysis for this study. The measures used for the present study are described below.

Measures

Antenatal Depression

Antenatal depression (AD) symptoms were measured using the Edinburgh Postnatal Depression Scale (EPDS) (Cox et al., 1987), a screening tool which consists of 10 self-report items focused on the cognitive and affective features of depression. The EPDS was originally designed to screen for postnatal depression. However, it has since been used in studies of pregnant women (Banti et al., 2011; Bennett et al. 2004; Bowen & Muhajarine, 2006; Evans et al., 2001; Korhonen et al., 2012; Rich-Edwards et al., 2006) and has been found to be valid in this population (Cox et al., 1996; Kozinszky & Dudas, 2015; Murray & Cox, 1990). The maximum score is 30 (each item is scored 0-3). Individuals with a score of 13 or greater are considered to have significant antenatal depressive symptoms, which will be referred to herein as EPDS-defined antenatal depression (EPDS-AD). At this cut-off, the EPDS has reported sensitivity and specificity for major depression in pregnancy of 0.83 and 0.90 respectively (NICE, 2014).

Sociodemographic variables

Ethnicity was defined as the mother's self-prioritised ethnicity, coded into five Level 1 Statistics New Zealand categories (Statistics New Zealand, 2005): European, Māori (New Zealand's indigenous population), Pacific Peoples, Asian, and Other (including Middle Eastern, Latin American and African). Educational qualifications and household income were classified according to measures from the Statistics New Zealand's national census (Statistics New

Zealand, 2006), General Social Survey (Statistics New Zealand, 2008), and the Core Questions module, a set of questions designed to allow comparability across social surveys (Statistics New Zealand, 2013).

Maternal age (<20 years, 20 – 29 years, 30 – 39 years, 40+ years), workforce participation (employed, unemployed or not in workforce, student) and relationship status (no relationship, dating but not cohabiting, cohabiting, married or civil union) were also self-reported.

Maternal health

Perceived general health *before* pregnancy was self-reported (5-point Likert scale from *excellent* to *poor* from the SF-36 general health questionnaire; Ware et al., 1994). Participants were asked whether they had ever been diagnosis with a depressive or anxiety disorder (categorised into never, before but not during this pregnancy before and during this pregnancy, and during this pregnancy only).

Perceived maternal stress was assessed using the abbreviated (10-item) Perceived Stress Scale (PSS; Cohen et al., 1983) which has established reliability and validity (e.g., Roberti et al., 2006). The maximum score is 40, with higher scores indicating greater stress.

Maternal height and pre-pregnancy weight were self-reported. Pre-pregnancy BMI was calculated (weight (kg)/height $(m)^2$), with BMI $\geq$ 25 kg/m^2 defined as overweight and $\geq$ 30 kg/m^2 as obese (WHO, 2007). Participants were asked to provide information about smoking status both before and during this pregnancy (not by trimester) and whether others in the household were smoking during this pregnancy. They were also asked about alcohol consumption both before and during this pregnancy (by trimester), and whether or not the pregnancy was planned.

Family cohesion

The 9-item Family Cohesion scale was specifically developed for *Growing Up in New Zealand* with good reliability and validity (Cronbach's alpha for mothers = .84 and fathers = .83). It is based on items from the Family Adaptation and Cohesion Scales (FACES III; Olson, 1985), developed with Māori concepts of whānau to more appropriately reflect the New Zealand context. The scores were used as a continuous variable for analysis, with higher scores relating to stronger feelings of family cohesion.

Neighbourhood support

The Neighbourhood Integration scale (Turrell et al., 2006) was a set of 10 questions with a 5-point response scale ranging from *strongly disagree* to *strongly agree* (e.g., I have a lot in common with people in my neighbourhood). The scores were used as a continuous variable for analysis, with higher scores relating to stronger feelings of neighbourhood integration.

Data Analysis

Chi-square analyses were used to determine the associations between depression status and sociodemographic variables, pregnancy-specific health and behaviors, family cohesion and neighborhood support. *t*-tests were used when outcomes were continuous (e.g., perceived stress score).

Hierarchical multiple logistic regression was used to test the associations between EPDS-AD and possible determinants. Sociodemographic variables were evaluated in the first model. Pre-pregnancy factors were then added to the model, followed early pregnancy factors and finally factors occurring later in pregnancy. Only variables that were significantly associated with

EPDS-AD at an alpha level of 0.1 in chi square analyses were used as predictors in the logistic regression analysis.

Analyses were carried out using version 22.0 IBM SPSS Statistics software. Statistical significance in the logistic regression analysis was given at an alpha level of .05.

RESULTS

Of 5,664 pregnant women, 672 (11.9%) had EPDS scores of 13 or above and were thus considered to have EPDS-AD.

The chi square test results indicating associations between EPDS-AD status and sociodemographc variables are presented in Table 1. All sociodemographic variables (age, ethnicity, education, workforce participation, household income and relationship status) except rurality were significantly associated with EPDS-AD (*ps* < .001). No significant association was found between EPDS-AD status and season of interview (X^2 = 1.08, p = .783).

Insert Table 1 about here

Associations were evident between several maternal health variables and EPDS-AD status (Table 2). Specifically, general health before pregnancy, long term disability, self-reported history of diagnosed depression or anxiety, pre-pregnancy BMI and whether or not the pregnancy was planned were all significantly associated with EPDS-AD status (*ps* < .001). Regarding health-related behaviours, smoking before or during pregnancy, whether or not others smoked in the house and alcohol consumption in the first trimester were significantly related to EPDS-AD status (*ps* < .01). Parity and alcohol consumption before pregnancy and after the first trimester were not related to depression status.

Insert Table 2 about here

Antenatal depression

t-tests revealed that mothers with EPDS-AD had significantly higher perceived stress scores (M = 21.33, SD = 4.95) than mothers without EPDS-AD (M = 11.98, SD = 5.73; Table 3). Mothers who were suffering from EPDS-AD also had lower family cohesion scores (M = 29.57, SD = 5.02) and neighbourhood integration scores (M = 33.14, SD = 5.32) than those who were not depressed according to the EPDS (family cohesion score M = 30.54, SD = 4.19; neighbourhood integration score M = 34.56, SD = 4.86; Table 3).

Insert Table 3 about here

Following the chi square and *t*-test analyses, a hierarchical multiple logistic regression was conducted including only variables that were significant in the univariate analyses. Sociodemographic variables (ethnicity, age, education, workforce participation, relationship status and household income) were assessed in the first model, followed by pre-pregnancy factors (general health before pregnancy, long term disability, self-reported depression and anxiety diagnoses, pre-pregnancy BMI and smoking behavior before pregnancy), then early pregnancy factors (planned pregnancy, smoking during pregnancy, others smoking in the same room and alcohol consumption in the first trimester) and finally later pregnancy factors (perceived stress, family cohesion and neighbourhood integration scores). The model containing only sociodemographic variables was significant (Model $X^2_{(18)} = 183.94$, $p < .001$). The inclusion of pre-pregnancy factors was also significant (Block $X^2_{(15)} = 156.05$, $p < .001$), as was the subsequent inclusion of early pregnancy factors (Block $X^2_{(4)} = 22.33$, $p < .001$) and the final addition of later pregnancy factors (Block $X^2_{(3)} = 675.50$, $p < .001$).

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Results from the final logistic regression model are provided in Table 4. Ethnicity ($p = .001$), self-reported anxiety diagnosis ($p < .001$) and perceived stress score ($p < .001$) were all significant predictors of EPDS-AD. Specifically, those of Pacific Islander ($p = .002$), Asian ($p = .003$) or Other ($p = .005$) ethnicity were approximately twice as likely to suffer from EPDS-AD than those of European ethnicity. Mothers who self-reported a diagnosis of anxiety both before and during their pregnancy were three times more likely to have EPDS-AD than those who were never diagnosed with anxiety ($p < .001$). Furthermore, a one point increase in perceived stress was associated with a 1.34 increase in the odds of having EPDS-AD ($p < .001$).

It is worth noting that although there was no significant overall effect for relationship status, group comparisons suggest that those who were in a relationship but not living with their partner during pregnancy were four times more likely to suffer from EPDS-AD than those who were married or in a civil union ($p = .04$). Similarly, although self-reported diagnosis of depression was not significant overall, group comparisons indicate that those who were depressed before and during pregnancy were 1.67 times more likely to have EPDS-AD than those who were never diagnosed with depression ($p = .049$). No other variables were significant predictors of EPDS-AD.

Insert Table 4 about here

DISCUSSION

Almost twelve percent (11.9%) of this ethnically and socioeconomically diverse cohort of *Growing Up in New Zealand* women had depression during pregnancy (according to the EPDS). Use of a validated tool (EPDS) to assess the presence of depression avoided the underestimation

of AD prevalence that occurs if the definition of AD is based upon physician diagnosis. As reviewed by Markus (2009), only a small number of women who meet criteria for a major depressive disorder seek medical treatment. In New Zealand, this is also true (Thio et al., 2006). Common symptoms of depression (sleep disruption, lack of energy, and appetite change) can also be misinterpreted as normal pregnancy-related experiences, making it more difficult to recognise the presence of AD.

The prevalence of AD symptoms found in our study (11.9%) was lower than that reported in a recent meta-analysis (Bennett *et al.*, 2004) and much lower than some individual studies, particularly those in Asia (Imran & Haider, 2010; Zeng et al., 2015). It is not clear whether this variability in rates is due to differing methods (such as the screening tool used or the sampling strategy) or whether there are differing underlying rates of AD in different cultures as suggested by Halbreich and Karkun (2006). Our finding that Pacific and Asian women were significantly more likely to report AD symptoms may support the latter notion.

Similar to our data, the Avon longitudinal study found that 13.5% of women in their 32nd week of pregnancy had EPDS-AD (Evans et al., 2001). This subsequently decreased to 9.1% at 8 weeks postpartum. A decrease in depression symptoms from the first trimester of pregnancy to 3-months postpartum was also found in a longitudinal study of Portuguese mothers (Figueiredo & Conde, 2011). However, a recent longitudinal study in Mexico found that the prevalence of depression symptoms increased from 16.6% prenatally to 20.0% at six months postpartum. (Lara, Navarrete, Nieto, Martín, Navarro, Lara-Tapia, 2015).

Several other studies, including population surveys not limited to mental-health service users, have suggested that AD is common, with reported prevalence as high as 20% (Heron et al., 2004;

Gavin et al., 2005). In contrast, one epidemiological survey found that pregnant women had a lower risk of mood disorder than non-pregnant women (except during the postpartum period), suggesting that pregnancy per se was not associated with an increased risk of depression (Vesga-López et al., 2008), and that depression observed during pregnancy may originate prior to pregnancy.

Depression is highly comorbid with anxiety (Hasin et al., 2005), and AD shares many risk factors with antenatal anxiety (Heron et al., 2004). Our finding that there is a significant association between EPDS scores and both anxiety and antenatal perceived stress are consistent with the literature. Vesga-López and colleagues (2008) found that stress as well as age, marital status, and health status were significantly associated with a higher risk of depression in pregnant women.

Ethnicity was significantly associated with probably depression, with women who identified their main ethnicity as Māori, Pacific or Asian reporting higher rates of depressive symptoms than those who identified as European. Our estimate of the prevalence of EPDS-AD in Pacific women (25.5%) is higher than the one previous estimate of EPDS-defined postnatal depression prevalence (16%; Abbott & Williams, 2006). However, caution is needed in interpreting these results, as the EPDS has not been fully validated for antenatal use with Māori, Pacific or Asian populations. For example, Abbott and Williams (2006) had ethnic prevalence rates ranging from 7.6% (Samoan participants) to 30.9% (Tongan); a subsequent EPDS validation study (Ekeroma et al., 2012) for postnatal depression has recommended a cut-off of 16+ for Tongan and 17+ for Samoan users of EPDS to improve predictive value.

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Ethnicity may be confounded by other variables, such as socioeconomic status (Prady et al., 2013) or immigration (Miszkurka et al., 2010). Evidence for an ethnicity-AD association has been defined as inconclusive or mixed (Lancaster et al., 2010), hampered by lack of clinical diagnostic measures (Gavin et al., 2011) and the multiple contextual factors related to ethnicity (Prady et al., 2013).

Smoking and alcohol have been previously shown to be associated with AD (Goedhart et al., 2009). Our study found that while smoking during pregnancy and alcohol use during the first trimester were both associated with an increased likelihood of EPDS-AD, the associations did not remain significant in the multiple logistic regression analysis. Given that this is the first report on mental health from our longitudinal study and hence that the analyses presented here are cross-sectional, causal relationships between depression and risk/protective factors cannot be ascertained. Some factors, such as smoking, may be a consequence of depression rather than a cause. It is well established that people who are depressed are more likely to smoke than those who are not depressed (Fergusson et al., 2003).

Relationship status was significantly associated with depression in univariable analysis; with women who were in a relationship but not living with their partner more likely to have EPDS-AD, suggesting that being pregnant and having the prospect of raising a baby without the support of an intimate partner has an adverse effect on maternal mental health. Also not surprising was that an unplanned pregnancy was more likely to be associated with EPDS-AD than planned pregnancy. EPDS-AD was also more likely to be reported by women experiencing less family cohesion and also by those who perceived their neighbourhood was less well integrated, in line with other evidence that lack of social support is associated with depressive symptoms in pregnancy (Lancaster et al., 2010; Pereira et al., 2011; Schmeid et al., 2013).

The potential limitations of this study need to be addressed. Considering that the women were in their third trimester of pregnancy at the interview, we cannot discount the possibility of recall bias for questions relating to pre-pregnancy status (e.g., perceived general health, weight estimation) or early-pregnancy behaviours (e.g., alcohol use, smoking, physical activity). Also, there is likely some measurement error (e.g., recall issues), particularly among depressed participants (e.g., family cohesion, alcohol use). Given the large sample size, we were unable to carry out any further assessment of the women in our study. As such, we do not have data on the diagnostic validity of the EPDS in our sample. This, together with the cross-sectional nature of this analysis, requires us to be cautious when interpreting our findings, particular those suggesting temporality or causation.

There were a number of strengths of the present study. Firstly, an objective and valid instrument was used to assess AD symptoms. Secondly, the findings are broadly generalisable to the contemporary cohort having children in New Zealand today. Thirdly, the broad research framework that was established for *Growing Up in New Zealand* allows us to consider not only demographic factors but also the contribution of the women's relationships with their partners, family and neighbourhood.

We showed that depression during pregnancy is highly prevalent, highlighting the need for healthcare practitioners to improve recognition and delivery of treatment for depression and to promote good mental health in pregnancy. Our findings indicate that the prevalence of EPDS-AD in New Zealand would justify further consideration of the potential benefits of screening of pregnant women for depression, in line with recommendations from both UK and US researchers and professional bodies (Koleva et al., 2011; Lancaster et al., 2010), albeit with the proviso that screening early in pregnancy should be repeated to rule out transient distress (Matthey and Ross-

Hamid, 2012). Suicide is the leading cause of maternal death in NZ (comprising a quarter of maternal deaths), further underpinning the need for antenatal screening for depression and associated suicidal ideation (PMMRC, 2013), and for training in effective assessment (Jones et al., 2012; King et al., 2012).

Conclusions

The number and diversity of women recruited are strengths of *Growing Up in New Zealand* and provide adequate explanatory power to examine complex outcomes across the whole cohort. In the near future, we will report the prevalence of postnatal depression among our cohort of women, and eventually the longer term effects on developing offspring. This knowledge will inform the development of strategies likely to improve the health, wellbeing and equity of outcomes for all New Zealand children and families, from before birth.

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Table 1.

Frequency distributions of EPDS-AD status and chi square test results for sociodemographic variables.

Variable	Not Depressed n (%)	Depressed[Ψ] n (%)	Pearson X^2
Age (N = 5664)			107.64**
<20 years	221 (4.4)	52 (7.7)	
20 – 29 years	1830 (36.7)	365 (54.3)	
30 – 39 years	2756 (55.2)	236 (35.1)	
≥ 40 years	185 (3.7)	19 (2.8)	
Ethnicity (N = 5656)			166.63**
European	2918 (58.5)	250 (37.7)	
Maori	616 (12.4)	131 (19.5)	
Pacific	555 (11.1)	171 (25.5)	
Asian	712 (14.3)	90 (13.4)	
Other	184 (3.7)	29 (4.3)	
Education (N = 5653)			119.91**
No secondary school qualification	271 (5.4)	81 (12.1)	
Secondary school qualification	1134 (22.8)	192 (28.7)	
Diploma/Trade certificate	1470 (29.5)	247 (36.9)	
Bachelor's or higher degree	2108 (42.3)	150 (22.4)	
Workforce participation (N = 5664)			75.05**
Employed	2848 (57.1)	267 (39.7)	
Unemployed/Not in workforce	1767 (35.4)	347 (51.6)	
Student	377 (7.6)	58 (8.6)	
Household income (N = 4814)			96.17**
≤ $30,000	361 (8.4)	88 (17.0)	
> $30,000 - ≤ $70,000	1231 (28.7)	203 (39.1)	
> $70,000 - ≤ $100,000	988 (23.0)	118 (22.7)	
> $100,000	1715 (39.9)	110 (21.2)	
Rurality (N = 5664)			1.73
Urban	4609 (92.3)	630 (93.8)	

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Rural	383 (7.7)	42 (6.3)	
Relationship status			143.66**
Single	210 (4.2)	77 (11.5)	
In a relationship, not cohabiting	167 (3.4)	55 (8.2)	
Cohabiting	1337 (26.8)	228 (34.1)	
Married/Civil union	3268 (65.6)	309 (46.2)	

Note: Ψ As defined by an Edinburgh Postnatal Depression Scale score of 13 or more

*$p < .05$, **$p < .01$.

Table 2.

Frequency distributions of EPDS-AD status and chi square test results for maternal health variables.

Variable	Not Depressed n (%)	Depressed[Ψ] n (%)	Pearson X^2
General health before pregnancy (N = 5659)			143.16**
Poor	80 (1.6)	37 (5.5)	
Fair	339 (6.8)	100 (14.9)	
Good	1628 (32.6)	268 (39.9)	
Very good	1873 (37.6)	183 (27.2)	
Excellent	1067 (21.4)	84 (12.5)	
Long term disability (N = 5662)			14.79**
No	4705 (94.3)	607 (90.5)	
Yes	286 (5.7)	64 (9.5)	
Self-reported depression diagnosis (N = 5660)			190.43**
Never	4180 (83.8)	465 (69.4)	
Before pregnancy, not during	635 (12.7)	101 (15.1)	
Before and during pregnancy	156 (3.1)	92 (13.7)	
Only this pregnancy	19 (0.4)	12 (1.8)	
Self-reported anxiety diagnosis (N = 5659)			162.82**
Never	4507 (90.4)	548 (81.5)	
Before pregnancy, not during	369 (7.4)	46 (6.8)	
Before and during pregnancy	86 (1.7)	64 (9.5)	
Only this pregnancy	25 (0.5)	14 (2.1)	
Pre-pregnancy BMI (N = 5043)			34.08**
< 18.5	186 (4.1)	22 (4.1)	
18.5 - < 25	2537 (56.3)	255 (47.4)	
25 - <30	1020 (22.6)	116 (21.6)	
$\geq$ 30	762 (16.9)	145 (27.0)	
Parity (N = 5664)			1.22
First born	2125 (42.6)	271 (40.3)	
Subsequent	2867 (57.4)	401 (59.7)	

	Antenatal depression		
Planed pregnancy (N = 5644)			148.88**
Yes	3218 (64.7)	270 (40.3)	
No	1756 (35.3)	400 (59.7)	
Smoking before pregnancy (N = 5664)			102.37**
No	4125 (82.6)	445 (66.2)	
Yes	867 (17.4)	227 (33.8)	
Smoking during pregnancy (N = 5664)			84.39**
No	4566 (91.5)	539 (80.2)	
Yes	426 (8.5)	133 (19.8)	
Others smoke in the house (N = 5664)			76.79**
No	4699 (94.1)	571 (85.0)	
Yes	293 (5.9)	101 (15.0)	
Alcohol before pregnancy (N = 5659)			2.47
No	1348 (27.0)	200 (29.9)	
Yes	3642 (73.0)	469 (70.1)	
Alcohol during 1st trimester (N = 5657)			17.26**
No	3875 (77.7)	474 (70.5)	
Yes	1110 (22.3)	198 (29.5)	
Alcohol after 1st trimester (N = 5664)			0.07
No	4298 (86.1)	581 (86.5)	
Yes	694 (13.9)	91 (13.5)	

Note: Ψ As defined by an Edinburgh Postnatal Depression Scale score of 13 or more

*$p < .05$, **$p < .01$.

Table 3.

Comparison of perceived stress, family cohesion and neighbourhood integration scores for mothers with and without EPDS-AD.

Variable	Not Depressed M (SD)	Depressed[Ψ] M (SD)	*t*
Perceived stress score[†]	11.98 (5.73)	21.33 (4.95)	45.09**
Family cohesion score[ǂ]	30.54 (4.19)	29.57 (5.02)	4.78**
Neighbourhood integration score [§]	34.56 (4.86)	33.14 (5.32)	6.57**

Note: Ψ As defined by an Edinburgh Postnatal Depression Scale score of 13 or more.
† Higher scores related to higher perceived stress.
ǂ Higher scores relate to stronger feelings of family cohesion.
§ Higher scores relate to stronger feelings of neighborhood integration.
*$p < .05$, **$p < .01$.

Table 4.

Multiple logistic regression evaluating the associations between EPDS-AD and socio-demographic, maternal health, family cohesion and neighbourhood integration variables.

Variable	B (SE)	OR	95% CI	Wald
Age				
<20 years	-.50 (.38)	0.61	0.29 – 1.27	1.76
20 – 29 years	.12 (.14)	1.13	0.85 – 1.49	0.70
30 – 39 years				3.51
≥ 40 years	.16 (.34)	1.17	0.60 – 2.28	0.22
Ethnicity				
European				18.87**
Maori	.15 (.21)	1.16	0.78 – 1.75	0.54
Pacific	.64 (.21)	1.90	1.27 – 2.84	9.78**
Asian	.60 (.20)	2.35	1.30 – 4.24	8.64**
Other	.86 (.30)	2.35	1.30 – 4.24	8.04**
Education				
No school qualification	.05 (.32)	1.05	0.57 – 1.97	0.03
Secondary school	-.004 (.19)	1.00	0.69 – 1.43	<0.001
Diploma/Trade certificate	.04 (.16)	1.04	0.75 – 1.43	0.05
Bachelor's or higher degree				0.10
Employed				2.82
Not in workforce	.24 (.14)	1.27	0.95 – 1.68	2.68
Student	.19 (.24)	1.21	0.76 – 1.91	0.64
Household income				
≤ $30,000	.04 (.26)	1.04	0.63 – 1.72	0.03
> $30,000 - ≤ $70,000	.06 (.18)	1.07	0.75 – 1.52	0.12
> $70,000 - ≤ $100,000	.21 (.18)	1.23	0.87 – 1.75	1.36
> $100,000				1.56
Relationship status				
Single	.17 (.33)	1.19	0.62 – 2.29	0.27

Dating, not cohabiting	.66 (.32)	1.94	1.03 – 3.64	4.21*
Cohabiting	.14 (.16)	1.15	0.84 – 1.56	0.79
Married/Civil union				4.31
General health before pregnancy				
Poor	.24 (.39)	1.27	0.59 – 2.71	0.38
Fair	-.20 (.27)	0.82	0.48 – 1.40	0.53
Good	.007 (.21)	1.01	0.68 – 1.50	0.001
Very good	.02 (.20)	1.02	0.69 – 1.52	0.01
Excellent				1.59
Long term disability				
No				
Yes	-.25 (.25)	0.78	0.48 – 1.27	0.98
Pre-pregnancy BMI				
< 18.5	-.31 (.32)	0.73	0.39 – 1.36	0.97
18.5 - < 25				1.42
25 - <30	-.04 (.16)	0.96	0.70 – 1.33	0.05
$\geq$ 30	-.14 (.17)	0.87	0.62 – 1.23	0.61
Self-reported depression diagnosis				
Never				4.16
Before pregnancy only	.15 (.18)	1.16	0.82 – 1.66	0.71
Before and during	.51 (.26)	1.67	1.00 – 2.78	3.88*
Only this pregnancy	.33 (.61)	1.39	0.42 – 4.65	0.29
Self-reported anxiety diagnosis				
Never				18.06**
Before pregnancy only	-.21 (.24)	0.81	0.51 – 1.29	0.80
Before and during	1.12 (.29)	3.08	1.73 – 5.47	14.65**
Only this pregnancy	.73 (.55)	2.07	0.71 – 6.06	1.76
Smoking before pregnancy				
No				
Yes	-.21 (.21)	0.81	0.54 – 1.23	0.99
Smoking during pregnancy				

No				
Yes	-.09 (.27)	0.92	0.54 – 1.56	0.11
Others smoke in the house				
No				
Yes	.01 (.24)	1.02	0.64 – 1.61	0.004
Planned pregnancy				
Yes	.26 (.14)	1.30	0.99 – 1.71	3.45
No				
Alcohol during 1st trimester				
No				
Yes	.26 (.15)	1.30	0.96 – 1.75	2.87
Perceived stress score	.29 (.01)	1.34	1.30 – 1.37	417.90**
Family cohesion score	-.01 (.01)	0.99	0.96 – 1.02	0.45
Neighbourhood integration score	-.004 (.01)	1.00	0.97 – 1.02	0.12

Note: *-2LL* = 1813.2; R^2 = .21 (Cox & Snell), .44 (Nagelkerke); Model $X^2_{(40)}$ = 1037.82, $p < .001$.

*$p < .05$, **$p < .01$.

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