Examining maternal depression, birthweight and linear growth: Findings from the South African National Income Dynamics Study

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Background. Literature is inconclusive regarding an association between maternal depression, low birthweight (LBW) and stunting in early childhood. While some studies have found an association, others have not. Maternal food insecurity is a risk factor for both maternal depression and reduced linear growth in early childhood.
Objective. This study examined the relationship between maternal depression, food insecurity, LBW and stunting in the first five years of life. The study employed longitudinal data of South African women and children from the National Income Dynamics Study (NIDS).
Methods. Mothers were classified into four groups: food insecure and depressed; food insecure only; depressed only; and neither food insecure nor depressed. During data collection, 22% of women were pregnant and the remaining 78% were pre-conception. The primary outcomes were low birthweight and height-for-age (HAZ) scores. Generalised Linear Mixed Effects (GLME) models were used to account for women having more than one child. GLME models with a Gaussian link function were used to compare mean differences in birthweight and HAZ scores. Multivariable regression models were used to examine factors associated with depression.
Results. Food insecurity was significantly associated with depression among pre-conceptional and pregnant women. There was no statistically significant difference in birthweight or linear growth across groups, but this may be influenced by proximity of depression measurement in relation to outcomes.
Conclusion. Food insecurity is a potentially modifiable risk factor for depression and may be a confounding factor in studies that have found associations between depression and child health outcomes.

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There is mixed evidence regarding an association between maternal depression in the pre-conceptional and pregnancy periods with both maternal and child health outcomes. Some studies find associations with outcomes that include pregnancy complications and reduced birthweight while other studies fail to do so.[1–5] Potential biological causal pathways for these associations include the release of stress hormones that may reduce placental blood flow and lead to subsequent restricted fetal growth and possible preterm birth.[3]

The evidence on maternal depression and stunting is also mixed, with some studies observing an association between maternal depression in the postnatal period and stunting in early childhood, while other studies find no association.[6–8] A review of the evidence base that examined the relationship between maternal depression and stunting in studies from Africa, South America and Asia, suggested a moderate statistically significant relationship between maternal depression and linear growth in children.[7] Although the causal pathways for this relationship remain unclear, it has been suggested that depressed mothers are less likely to breastfeed and that the children of depressed mothers experience more frequent episodes of childhood illnesses that may compromise linear growth.[7]

Numerous studies have noted an association between food insecurity and maternal depression during pregnancy.[9–11] Other risk factors for maternal depression include intimate partner violence, low educational attainment, and a lack of social support.[9] In addition to individual exposures, observational epidemiological studies suggest that household-level traumatic events could be associated with maternal depression. For example, food insecurity or the illness of a household member can be related to the onset of depressive symptoms, suggesting a complex causal pathway.[10,12] There has been little research exploring the role of these factors in relation to both maternal depression and child health outcomes in low- and middle-income countries (LMIC).

This study sought to fill a gap in the literature by using cohort data on South African women and their offspring to address two aims: (*i*) examine household stressors and other factors associated with maternal depression in the pre-conception period and during pregnancy; and (*ii*) examine the relationship between maternal depression and food insecurity (both pre-conception and during pregnancy) in relation to birthweight and linear growth in early childhood.

Methods

Study design and sample

This study analysed publicly available data from Wave 1 (2008) and Wave 3 (2012) of the South African National Income Dynamics Study (SA-NIDS), a nationally representative panel survey of households in South Africa.[13] A retrospective cohort method was used, and focused on early childhood health outcomes among 1 431 children in relation to maternal exposures of food insecurity and depression among 1 208 women who gave birth between Wave 1 and Wave 2 of

NIDS (2008-2011). During data collection in Wave 1, most women (78%) were pre-conception and 22% were pregnant.

Data collection

Food insecurity information was only available in Wave 1 of NIDS (2008). Depression data and individual maternal characteristics were also collected in Wave 1. Maternal data from Wave 1 were matched with child data from Wave 3 (2012).

Ethics approval

The SA-NIDS was approved by the Ethics Committee of the Commerce Faculty, University of Cape Town, and the de-identified data sets are publicly available. Ethics approval for this secondary analysis, which is part of a doctoral thesis of the first author (AH), was obtained from the University of the Witwatersrand Research Ethics Committee (protocol number M1909101). The components of the secondary analysis on which this paper is based are described below.

Inclusion and exclusion criteria

The analysis was limited to women aged between 15 and 44, as both younger adolescents and older women are at increased risk of obstetric complications and LBW and may differ systematically from the average pregnant woman.[14] Women who had recently given birth were excluded, as the aetiology and consequences of postnatal depression may differ from that in the pre-conception or pregnancy period. Children were aged between one and five years at the time of data collection in Wave 3, with a mean age of 30.7 months.

Measures

Depression

Depression was both an outcome and an exposure in this study. Maternal depressive symptoms were measured using the CES-D (Center for Epidemiologic Studies Depression Scale). This 10-item Likert scale questionnaire measures depressive symptoms in the preceding week.[13] It includes three items on depressed affect, five items on somatic symptoms, and two on positive affect. Total scores can range from 0 to 30, with increased scores indicative of more severe symptoms. A recent validation study recommended a cut-off of between 11 and 13 for a South African population depending on the language of the CES-D translation used in the survey (Afrikaans, Zulu or Xhosa).[15] This study sample consisted of predominantly Zulu and Xhosa speakers; a cut-off of 12 was therefore used to define depressive symptoms.

Food insecurity

The severity of food insecurity was described by means of a continuous score between 0 and 6, using multidimensional poverty measurement. This adapted composite measure of food security includes three separate domains: anxiety about food supply; food quality; and food utilisation. Individual indicators include adult and child hunger; household food sufficiency; dietary diversity; proportion of household expenditure on food; and maternal underweight BMI.[16] Each indicator is assigned a value of 0 or 1, with the final score being a minimum of 0 (food secure) and a maximum of 6 (severely food insecure). The final score was examined as a continuous and binary (domain insecure) variable.

Maternal and household characteristics associated with depression

The NIDS questionnaire includes self-reported household stressors such as a household member becoming ill; crop failure; or a social grant ending in the preceding 24 months. The authors examined these as well as maternal socio-demographic characteristics for associations with depression. Socio-demographic characteristics included maternal age categories pre-defined by the NIDS investigators; number of years of education; employment status; marital status; having ever given birth before; and social grant status.

Outcomes

The primary outcomes are a comparison of means of infant birthweight in grams and a comparison of means of childhood HAZ scores in the first five years of life. Children's Z scores were calculated using the WHO child growth standards.[17]

Data analysis

Descriptive analysis

GLME models were used to account for clustering due to multiple births or mothers who gave birth more than once during the reference period. A GLME model with a logit link function was used to explore food security indicators, household stressors and maternal characteristics associated with depression. Significant variables were included in the final multivariate regression model. To avoid collinearity in the final model, the authors included only the composite food security score and excluded individual indicators.

In the second part of analyses that focused on child health outcomes, children were classified according to the following four maternal categories: (*i*) mother depressed only; (*ii*) mother food insecure only; (*iii*) mother both food insecure and depressed; and (*iv*) mother neither depressed nor food insecure (reference category) in Wave 1. A GLME model with a Gaussian link function was used to compare differences in mean birthweight and HAZ scores among children. Analyses were conducted using post-stratification weights to adjust for the panel design of the study.

Results

Tables 1 and 2 present results of bivariate and multivariate characteristics associated with depression. Data were matched from 1 208 mothers with 1 431 children. Birthweight data were available for 1 211 children and HAZ scores for 1 254 children. Table 3 presents the mean birthweight in grams and Table 4 the HAZ scores with maternal depression and food insecurity as exposures. For both birthweight and HAZ scores, the largest group was children whose mothers were neither food insecure nor depressed; followed by children of mothers who were food insecure only; and then children whose mothers were depressed only. The smallest group comprised children whose mothers were both food insecure and depressed.

The initial bivariate analyses in Table 1 found that most of the food security indicators as well as the composite score were significantly associated with maternal depression. The food security indicators most strongly associated were self-reported adult and child hunger in the household in the preceding 12 months. The maternal characteristics most strongly associated with depression were maternal age between 35 and 39 years and having previously given birth. Increased years of maternal education had a protective effect.

In the final multivariable model, the food security score and years of maternal education were the only factors significantly associated with depression, with each additional year of education reducing the risk of depression.

There was no statistically or clinically significant difference in birthweight between groups. Of the four categories, the lowest mean birthweight was found among women who were food insecure only, followed by women who were depressed only. The highest mean

birthweight was found among women who were both depressed and food insecure; but this group was very small (5.7% of the total sample). Notably, mean birthweight in depressed and/or food insecure groups were all above 3 000g, well above the cut-off for LBW.

There was no statistically or clinically significant difference in HAZ scores between the groups. The lowest HAZ scores were found among the children of women who were both depressed and food insecure; on average, their height differed by 0.43 SD from that of children in the reference category. The children in the reference category had the highest HAZ scores.

Discussion

This study has yielded several important findings, both significant and non-significant. Significant findings include: prevalence estimates of food insecurity and depression of 27% and 18.46%, respectively. Most of the food security indicators were significantly associated with an increased risk of depression, while each additional year of maternal education offered a protective effect (Tables 1 and 2). The study found no significant differences in birthweight or HAZ scores across groups in relation to maternal depression (Tables 3 and 4).

The prevalence estimates of food insecurity and depression are not surprising when compared with previous studies despite the use of different measures. Depression prevalence was 18.46%: a similar finding to other studies that have examined antenatal depression among South African women.[2,10] In our final multivariable model, each unit increase of the food security score was associated with a 28% increased likelihood of depression. This association has been well described in several studies from LMIC and high-income settings and remains across studies despite the use of different measures for both food insecurity and depression.[10,18,19] Notably, each unit increase of dietary diversity reduced the risk of depression by 10% in this sample, highlighting that the causal pathway between food insecurity and depression may be twofold. The stress and anxiety of insufficient food as well as the adverse physiological outcomes of a poor-quality diet and insufficient micronutrients may both contribute to low mood. In the final model, each additional year of maternal education offered a protective effect against depression, an effect that has been observed in studies of the antenatal and postnatal period and reinforces the value of investing in education for girls.[20]

The finding that maternal depression was not associated with a statistically significant decrease in birthweight (Table 3) has been observed in several studies from South Africa, Pakistan, the US and Korea.[2,21–23] However, some studies have suggested an association between depression and gestational age, a factor not measured in this study.[23,24] In contrast to our findings, another study using NIDS data did find an association with LBW in mothers who were depressed prior to their pregnancies, but some differences may be attributable to methodological differences. For example, the study was conducted prior to the validation study cited earlier and used a cut-off of 10 to

Table 1. Bivariate analyses of food security indicators and maternal characteristics associated with depression during the pre-conception period and pregnancy

Household characteristics associated with depression	Unadjusted OR (95% CI)	*p*-value
Food security score (*N*=1 208)	1.25 (1.13 - 1.37)	<0.001
Hungry child in household (*N*=1 115)	1.70 (1.20 - 2.40)	0.003
Hungry adult in household (*N*=1 204)	1.62 (1.18 - 2.24)	0.003
Domain insecure (*N*=1 208)	1.44 (1.05 - 1.98)	0.022
Dietary diversity (continuous) (*N*=1 205)	0.90 (0.85 - 0.96)	0.002
Maternal age 35-39 (*N*=1 205)	1.82 (1.01 - 3.28)	0.046
Previously given birth (*N*=1 148)	1.64 (1.19 - 2.26)	0.003
Maternal education in years (continuous) (*N*=1 207)	0.91 (0.86 - 0.96)	<0.001

Table 2. Multivariable model of factors associated with depression during the pre-conception period and during pregnancy

Depression (*N*=223) 18.46% prevalence	Adjusted coefficient (95% CI)	*p*-value
Composite food security score	1.28 (1.14 - 1.45)	<0.001
Maternal education	0.90 (0.84 - 0.97)	0.008

Table 3. Mean birthweight by exposures to maternal depression and food insecurity

Maternal status	Mean birthweight in grams (95% CI)	Coefficient (SE)	*p*-value
Depressed only (*N*=147)	3 051 (2 962 - 3 141)	-7.33 (52.71)	0.889
Food insecure only (*N*=259)	3 045 (2 945 - 3 146)	22.69 (38.75)	0.558
Food insecure and depressed (*N*=69)	3 117 (3 002 - 3 233)	83.76 (71.35)	0.240
Not depressed or food insecure (*N*=736)	3 115 (3 045 - 3 182)	Reference group	

Table 4. Mean and HAZ scores by exposure to maternal depression and food insecurity

Maternal status	Mean HAZ (95% CI)	Coefficient (SE)	*p*-value
Depressed only (*N*=148)	-1.03 (-1.52 - 0.64)	0.058 (0.18)	0.747
Food insecure only (*N*=261)	-1.27 (-1.55 - 1.00)	0.032 (0.132)	0.807
Food insecure and depressed (*N*=76)	-1.46 (-2.04 - 0.89)	-0.138 (0.226)	0.542
Not depressed or food insecure (*N*=769)	-1.03 (-2.04 - 0.89)	Reference group	

define depressive symptoms as well as examining birthweight as a binary outcome.[1,15] Two studies that found associations between LBW and maternal depression noted that the magnitude of the effect varies as a function of depression measurement and geographical location, with women in developing countries at greater risk for LBW and preterm birth, a risk factor for LBW.[3,25] Notably, the children of women in the food insecure group had the lowest mean birthweight but depression did not appear to play an additional role. In the case of HAZ scores, the combination of depression and food insecurity had the greatest deviations from the norm, partly due to the small sample size of this group. The authors of the study examined the outcomes of interest across four different groups and dividing the food insecure into two separate categories may have reduced sample size to the degree that differences were no longer statistically significant.

The impact of maternal depression on birthweight and child growth outcomes is complex, as the severity, time of assessment and length of depressive symptoms must be considered through consistent repeated measurement and longitudinal designs. Our study did not include repeated assessments of depression and may therefore have missed women with chronic depression. In addition, the use of a cut-off limits information on the severity of depression between women. Research in a low-income community in South Africa found that depressive symptoms during pregnancy subsided during the postpartum phase for over 90% of women, suggesting that depression in this stage tends to be episodic for the majority of women.[11] The finding of the CES-D validation study in South Africa that different cut-offs across language groups maximise sensitivity and specificity highlights the complexity of interpreting depression prevalence estimates in ethnically and culturally diverse populations like South Africa.[15]

We found no significant association between maternal depression and linear growth in early childhood (Table 4). This may be partially due to the proximity of depression measurement in relation to the outcome, as our study did not examine postnatal depression. However, these findings are consistent with another study that explored postpartum depression at 2 and 18 months in relation to early childhood growth in an informal settlement in South Africa and did not find an association.[8] In contrast to our findings, some studies from South Asia and Africa have found a significant association with early childhood stunting and maternal depression.[7,26] The LMIC where associations between maternal depression and reduced linear growth have been found include Ethiopia, Pakistan, India and Zambia: all countries where food and diet; household food security; socioeconomic status; and breastfeeding practices may vary considerably from those in South Africa. Food insecurity in particular may be an important confounding factor that can contribute to maternal depression as well as birthweight and linear growth but is not sufficiently explored or adjusted for in systematic reviews on stunting or birthweight.[3,7,25]

In the final model, each additional year of maternal education offered a protective effect against depression, an effect that has been observed in studies during the antenatal period and reinforces the value of investing in education for girls.[20] The finding that parity as well as the presence of a hungry child in the household increases the risk of depression among women during pregnancy has been observed in two other South African studies.[11,14] Initial bivariate analyses noted that women who had previously given birth were more likely to be depressed than first time mothers. Thus, the addition of more children in the household puts a greater strain on scarce resources and increases the risk of household food insecurity and depression among women in LMIC settings.

Study limitations

Longitudinal information was not available on food security and the authors assumed that food security and/or depression status would continue during pregnancy and postnatally for some women in the sample. Depression data for most of this sample were collected before conception and this may limit inferences about depression and child outcomes. The CES-D is a general screening tool, not specifically related to pregnancy or postnatal depression and does not constitute a clinical diagnosis of depression. The data do not include information on preterm birth, an important risk factor for LBW.

Conclusion

This study highlighted the profound impact of food insecurity on maternal depression but found no statistically significant difference in relation to birthweight or linear growth across groups. We suggest rigorous longitudinal research to examine both the relationships between food insecurity and antenatal depression and to clarify the effect of the latter on child growth. Furthermore, intervention research designs should be used to examine the effects of strategies that alleviate maternal food insecurity during pregnancy such as a proposed extension of the child support grant (CSG) into pregnancy. Such interventions may reduce the incidence of depression and improve maternal mental health outcomes in the South African context.

Declaration. This paper is included as a chapter in the PhD thesis of the first author (AH).

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Author contributions. AH, SM and AR were involved in conceptualising the study design. AH performed the analyses while EC provided statistical oversight. AH, SM and AR all contributed to writing the article. All authors reviewed and approved the final manuscript.

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