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Research paper

Perinatal maternal depression in rural South Africa: Child outcomes over the first two years

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ABSTRACT

Aims: To examine child outcomes over time among mothers with perinatally depressed mood in rural South Africa (SA).

Methods: A representative sample of consecutive births (470/493) in the OR Tambo District of the Eastern Cape of South Africa (SA) were recruited and were reassessed at five points over the course of the next two years: 85% were reassessed at 3 months, 92% at 6 months, 88% at 9 months, 91% at 12 months, and 88% at 2 years post-birth. Over time, the children of mothers with perinatally depressed mood (16%) were compared to children of mothers without depressed mood using multiple linear and logistic regressions.

Results: Mothers with perinatal depressed mood are significantly less likely to live with the child's father or their in-laws (23% vs 35%), have household incomes above 2000 ZAR (154 USD) (31% vs 51%), and significantly more likely to have experienced IPV prior (19% vs 9%) and during (32% vs 20%) pregnancy compared to mothers without depressed mood. There are no differences in age, education, primipara, HIV status (29% seropositive), or alcohol use. Growth and developmental delays and motor and speech milestones through 24 months post-birth are similar for mothers with and without perinatal depressed mood.

Conclusions: Despite increased economic and partner difficulties associated with perinatal depressed mood, infant outcomes are similar in mothers with and without depressed mood in rural South Africa.

1. Introduction

The negative consequences of perinatal depression on mothers and their children are well-established in high income countries (HIC) (Brand and Brennan, 2009; Diego et al., 2004; Steer et al., 1992) and in more recent studies in low- and middle-income countries (LMIC) (Stein et al., 2014; Fisher et al., 2012). A recent meta-analytic review of the prevalence of perinatal depression globally (n = 17 countries) suggests prevalence rates of 5–30% in LMIC (Fisher et al., 2012). In South Africa, several studies in peri-urban settlements near Cape Town report high rates of perinatal depression with over 30% of pregnant women reporting depressive symptoms (Honikman et al., 2012; Rochat et al., 2011; Rotheram-Borus et al., 2011). However, less is known about the rates of depression among pregnant women in rural areas.

In rural regions of LMIC, there are many challenges facing mothers. Maternal depression has been linked to poverty, age, prior history of mental health problems, having unintended children, and intimate partner violence (Fisher et al., 2012). In the Eastern Cape, poverty is pervasive and mothers often care for their children without their partners who migrate in search of work (Posel and Devey, 2006). Partner support is limited both financially and emotionally and intimate partner violence is also prevalent in this region (Nduna et al., 2010). With scarce employment opportunities and partner support, government assistance provided with the child support grant (CSG) is essential for all mothers. However, applying for this grant requires mothers to submit an application that includes their own identification documents and their child's birth certificate to the nearest South African Social Security Agency office. This process can be difficult in geographically isolated areas such as the Eastern Cape, where mothers have large distances to travel and limited means of transportation. Considering the importance of this

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financial support in low-resource areas, we examine the time it takes mothers to obtain the CSG in the Eastern Cape.

Further, mothers living with HIV have been found to have higher rates of depression (Rotheram-Borus et al., 2011; Dyer et al., 2012; le Roux et al., 2013). In SA, pregnancy is the period during which young women are most likely to find out their HIV status – more than 98% of women will get tested for HIV while attending antenatal care (National Antenatal Sentinel HIV Prevalence Survey, 2013). In the Eastern Cape, nearly one in three mothers will learn that they are HIV positive which places them and their child at lifelong risk for premature death and negative health outcomes (Rochat et al., 2006; Tanser et al., 2013). Concurrently, 25% of mothers in peri-urban townships near Cape Town drink alcohol while pregnant (Rotheram-Borus et al., 2015; Tomlinson et al., 2014). Although alcohol use among pregnant mothers in rural areas is less understood, homemade alcohol is a common economic activity in this area (Fieldgate et al., 2013). This can serve as a source of household income and possibly increase the risk for use and dependency. In this study, we examined the structural, health, and risk factors between mothers reporting perinatally depressed and non-depressed moods in a South African rural setting.

Maternal depression affects the well-being of the mothers as well as their children. Low birth weight, shorter duration of breastfeeding, undernutrition, and diarrhea have been associated with maternal depression (Rahman et al., 2007, 2008, 2009). Children's poor growth has been consistently linked to maternal depression in Southern Asian countries but has more inconsistent patterns in African nations (Patel et al., 2004; Parsons et al., 2012; Rahman et al., 2009). Depressed mothers living with HIV, even when children are uninfected with HIV, have children with poor growth (Stein et al., 2014). A recent meta-analysis reported a small but significant effect when assessing the influence of perinatal depression on cognitive functioning in children but a larger effect when considering postnatal maternal depression (Fisher et al., 2012).

This article examines the influence of perinatal depression on child outcomes through the first two years of life among a population cohort of mothers in a rural region in the Eastern Cape of South Africa. Having repeated assessments of this population cohort allowed us to examine multiple child outcomes over 24 months. We hypothesized that mothers experiencing perinatal depressed mood may have less structural resources (e.g., income, formal housing) and experience more risk (e.g., IPV, alcohol use). With these challenges, mothers with depressed mood may be less able to caretake for their children, resulting in developmental delays.

2. Methods

The study was conducted with approval of the Institutional Review Board of the Stellenbosch University (N12/08/046) and permission was granted by the Eastern Cape Department of Health to recruit in government health facilities.

2.1. Setting

Zithulele Hospital in the King Sabata Dalindyebo (KSD) Sub-district of the OR Tambo District of the Eastern Cape of SA serves a population of approximately 130,000 and is the referral center that provides training infrastructure for staff at 14 surrounding health clinics and it serves one of the two poorest municipalities in SA (BusinessTech, 2016).

Between January and April of 2013, a consecutive series of mothers giving birth at Zithulele Hospital and its 10 closest clinics were approached to participate in a birth cohort study. In addition, mothers who delivered at home (10.1%) or on the way to a health facility (3.2%) who sought follow-up care at one of these clinics were also approached. Mothers who travelled to the hospital from outside this catchment area to give birth at the hospital were excluded from the sample, due lack of funding for distant follow up. Voluntary informed consent was obtained from 95% of mothers (470/493 live births; 5% refusal/exclusion rate) and, in the case where the mother was less than 18 years old, consent was obtained from the adolescent mother and one of her parents/guardians. Mothers were approached while still in the hospital and interviewed in the first few days following birth. Mothers giving birth at clinics were assessed within the first week following birth; mothers giving birth at home were approached at the first post-natal clinic visit, and were in most cases assessed within the first two weeks of life. Mothers visit clinics as soon as possible after a home birth in order to secure a government Road to Health Card (RtHC). Not only is the RtHC a type of health passport and, therefore, an important health record, it also serves as proof of birth and is used to apply for a birth certificate, which is then used to apply for a child support grants (R250 per month in 2013) from the South African Social Security Agency (SASSA).

Mothers were reassessed at five points over the course of the next two years: 85% (n = 390/460) were reassessed at 3 months, 92% at 6 months (n = 420/456), 88% at 9 months (n = 410/454), 91% at 12 months (n = 411/450), and 88% at 2 years (n = 396/450) post-birth. Twenty-two infants died in the first year, two of whom were the second twin and are therefore not included in this analysis. No deaths were recorded the second year of the study.

2.2. Training

Local, isiXhosa speaking women were trained as interviewers, using role play to train mock interviews in the field over a six-week time period. Interviewers collected data on mobile phones which were pre-programmed with assessment questions by the Mobenzi mobile phone team (https://www.mobenzi.com/). The following measures were completed at each assessment point.

2.3. Maternal Measures at Birth

Maternal depression was reported on the Edinburgh Postnatal Depression Scale (EPDS) (Cox et al., 1987; Lawrie et al., 1998). The EPDS has been translated and used across numerous cultural contexts (Husain et al., 2014; Patel et al., 2003; Shrestha et al., 2016) including South Africa (Rochat et al., 2013; Tomlinson et al., 2014). In South Africa, the EPDS has demonstrated good internal reliability, with a Cronbach's alpha of 0.87 (Hartley et al., 2011) and construct validity (De Bruin et al., 2004). We report both the mean scale score and identify mothers whose responses indicate probable depressive disorder (i.e., using a cut-off of >13 to indicate depressed mood) (Rochat et al., 2013). *Structural resources* were identified as education, employment, income, living with a partner, water on the premises, and electricity. *Intimate partner violence (IPV)* was self-reported at the baseline interview with four items adapted from Jewkes et al. (2002, 2003). Mothers were asked four items referring to the past 12 months: if they were slapped or had anything thrown at them; were pushed or shoved; were punched with a fist or another object; or were attacked or threatened with a weapon by their partner. *Alcohol use*. The frequency of drinking alcohol was assessed as 0, never drinking, and 1, having had at least one drink in the past three months. *HIV status* was self-reported by mothers at each assessment; maternal status is also reported on the mother's antenatal card and their child's government-issued Road-to-Health card. *Number of antenatal visits*. The percentage of mothers who completed the recommended number of antenatal appointments (four) was recorded. *Alloparenting*. Mothers self-reported whether they were the child's primary caregiver at each assessment.

2.4. Child measures over time

Low birth weight was recorded for those infants born weighing less than 2500 g. Weight and height were measured by trained and certified interviewers on measuring mats and on electronic scales which were

Table 1
Differences between baseline characteristics at birth by mothers' depressed mood.

	No depressed mood (EPDS < 13) $N = 395$	Depressed mood (EPDS > 13) $N = 73$	All mothers $N = 468$
Demographic & structural characteristics			
Mean age (SD)	24.8 (7.1)	25.4 (7.7)	24.9 (7.2)
Mean highest education level (SD)	8.6 (2.4)	8.6 (2.4)	8.6 (2.4)
Live with father or family*	35% (139)	23% (17)	33% (94)
Monthly household income >2000Rand**	51% (194/379)	31% (21/68)	48% (215/447)
Water tank on site	17% (69)	10% (7)	16% (76)
Electricity	17% (67)	8% (6)	16% (73)
Mean household members (SD)	5.4 (2.8)	6.0 (3.0)	5.9 (2.9)
Intended to apply for child support grant	97% (383)	96% (70)	97% (453)
Maternal health			
Mean EPDS	6.1 (3.6)	17.6 (3.3)	7.9 (5.5)
Primipara	40% (157)	38% (28)	40% (185)
Four+ antenatal clinic appointments	48%(132/275)	38% (8/21)	47% (140/296)
HIV positive	28% (110)	30% (22)	28% (132)
Alcohol and domestic violence			
Alcohol before learning of pregnancy	11% (44)	12% (9)	11% (53)
Alcohol after learning of pregnancy	6% (25)	8% (6)	7% (31)
Domestic violence previously*	9% (37)	19% (14)	11% (51)
Domestic violence during pregnancy*	20% (80)	32% (23)	22% (103)
Children growth measures			
Mean HAZ scores (SD)	−0.18 (1.15)	−0.08 (1.13)	−0.16 (1.14)
Mean WAZ scores (SD)	−0.62 (0.99)	−0.46 (0.98)	−0.59 (0.99)
Mean WHZ scores (SD)	−0.70 (1.31)	−0.46 (1.30)	−0.66 (1.31)
Low birth weight	12% (39/330)	9% (6/68)	11% (45/398)

Note. p values from linear (continuous variables) and logistic (binary) mixed effect regressions. Denominators shown for variables with missing data.
* $p < .05$.
** $p < .01$.

recalibrated weekly. Children's weight and height measures were then converted to z-scores based on the World Health Organization's (WHO) age-adjusted norms (http://www.who.int/childgrowth/standards/en/). *Growth* at birth, 3, 6, 9, 12, and 24 months is reflected in standardized scores (Z scores) for height-for-age (HAZ), weight-for-age (WAZ), and weight-for-length/height-for-age (WHZ). A z-score below −2SD was considered a serious health deficit, as being stunted (> −2SD for HAZ) or malnourished (> −2 SD for WAZ) (De Onis and Blössner, 2003). *Received the child support grant.* Whether or not the mother was receiving the South African child support grant (CSG) was recorded at birth, 3, 6, 9,12, and 24 months. *Developmental Milestones.* The gross motor developmental milestones of the WHO for children at 6 (WHO1), 9 (WHO3), 12 (WHO1-5) and 24 months (WHO1-6) were administered (Wijnhoven et al., 2004; Lansdown et al., 1996). These include six milestones that are fundamental to acquiring self-sufficient locomotion: sitting without support, hands-and-knees crawling, standing with assistance, walking with assistance, standing alone, and walking alone (De Onis et al., 2006). Tasks were coded as follows: if the milestones were completed (1), if the child refused or was unable to complete the task (0).

2.5. Analysis

The primary analysis compared maternal and child outcomes for mothers with (EPDS > 13) and without (EPDS </= 13) depressed moods at birth using mixed effects regression models, with mothers without depressed moods as the reference group. Logistic mixed effects regression models were used for binary outcomes and linear mixed effects regression models were used for continuous outcomes (i.e., age, education level, and number of household members). All models were adjusted for repeated measures, where appropriate, and a random participant effect to control for the longitudinal nature of the assessments was used. Longitudinal linear mixed effects regression models were used to compare child growth scores between children of mothers with and without depressed moods over the first two years of life and were adjusted for child sex and baseline household income. One HIV-positive child was omitted from the analyses. EPDS for one mother at birth was missing so this mother and her child were omitted from the analysis. The regression models were carried out using IBM SPSS Statistics (Version 20, Armonk, NY: IBM Corp).

3. Results

Table 1 summarizes the characteristics of the mothers with and without depressed mood at the point of recruitment at child-birth. There were 16% (73/468) of children born to mothers with perinatal depressed mood. Mothers with depressed moods were significantly less likely to be living with the child's father or their in-laws (23% vs 35%, $OR = 0.56$, *95% C.I.* = [0.31, 0.99], $p = .05$) and have household incomes above 2000 ZAR (31% vs 51%, $OR = 0.43$, *95% C.I.* = [0.25, 0.74], $p = .002$). There were no significant differences amongst the mothers in age ($M = 24.9$ years, $SD = 7.2$), education ($M = 8.6$ years, $SD = 2.4$), if there was a water tank on site or electricity in the household (16%), number of people living in the household ($M = 5.9$, $SD = 2.9$), primipara (40%), having the recommended four antenatal clinic appointments (47%), HIV status (28% seropositive), or alcohol use (11% before learning about pregnancy and 7% after learning of pregnancy). However, mothers with depressed mood were more likely to experience IPV than mothers without depressed mood ($B = 0.83$, *Std. Error* = 0.34, *95% C.I.* = [0.16, 1.51], $p = .016$). Mothers were more likely to report IPV during pregnancy than prior whether they had depressed moods or not ($B = 0.90$, *Std. Error* = 0.15, *95% C.I.* = [1.19, 1.19], $p < .001$).

At birth, there were no significant differences in HAZ, WAZ, WHZ scores, or low birth weight children of mothers with and without depressed mood (11%).

Table 2 summarizes the cumulative support for children over time by mothers' depression. By 12 months, about 75% of all mothers had begun receiving the child support grant. However, by 24 months, mothers with depressed mood were significantly less likely to have obtained the child support grant than mothers without depressed mood (82% vs 91%, $OR = 0.43$, *95% C.I.* = [0.20, 0.94], $p = .035$). By 24 months, the majority of children had up-to-date immunizations, although immunization rates in this population were too low to ensure

Table 2
Cumulative support for children over time (months) by mothers' depressed mood.

Depressed mood EPDS >13		Birth (*N* = 468)	3 Months (*N* = 389)	6 Months (*N* = 417)	9 Months (*N* = 399)	12 Months (*N* = 408)	24 Months (*N* = 395)
Received child support grant	No	–	37%	67%	76%	79%	91%
	Yes	–	34%	61%	73%	68%	82%
Exclusive breastfeeding	No	–	21% (70/328)	9% (31/351)	–	–	–
	Yes	–	18% (11/60)	6% (4/66)	–	–	–
Up-to-date immunizations	No	–	49% (148/305)	70% (244/351)	83% (255/308)	74% (228/309)	74% (224/304)
	Yes	–	49% (26/53)	79% (48/61)	89% (50/56)	68% (39/57)	69% (34/49)
Stunting HAZ < 2 SD	No	7%	3%	6%	6%	8%	8%
	Yes	6%	5%	3%	9%	9%	6%
Malnourished WAZ < 2 SD	No	10%	4%	6%	3%	4%	3%
	Yes	10%	3%	0%	3%	4%	2%
WHZ < 2 SD	No	18%	9%	4%	3%	4%	3%
	Yes	16%	13%	6%	0%	2%	6%
WHO gross motor milestones completed	No	–	–	88% (308/351)	94% (318/337)	76%(250/329)	99% (334/339)
	Yes	–	–	89% (59/66)	94% (58/62)	73% (41/56)	98% (55/56)

Note: At birth, there were no immunizations. Denominators shown for variables with missing data.

heard immunity for measles (Le Roux et al., 2017). In addition, children of mothers with and without depressed mood exclusively breastfeed at similar rates (8% for six months) and experience a similar rate of alloparenting by 24 months post-birth (34%). There were no significant differences between children of mothers with and without depressed mood in HAZ, WAZ, WHZ, low birth weight, stunting or malnourished scores, or in developmental motor, social, and speech milestones through 24 months post-birth. Overall, children's WAZ and WHZ significantly increased over 24 months. WAZ increased from birth at three (*Estimate* = 0.46, *S.E.* = 0.05, $p < .001$, *95% C.I.* = [0.38, 0.55]), six (*Estimate* = 0.71, *S.E.* = 0.05, $p < .001$, *95% C.I.* = [0.60, 0.82]), nine (*Estimate* = 0.80, *S.E.* = 0.06, $p < .001$, *95% C.I.* = [0.69, 0.92], 12 (*Estimate* = 0.74, *S.E.* = 0.06, $p < .001$, *95% C.I.* = [0.62, 0.86], and 24 (*Estimate* = 0.78, *S.E.* = 0.06, $p < .001$, *95% C.I.* = [0.67, 0.90]) months. WHZ increased from birth at three (*Estimate* = 0.34, *S.E.* = 0.06, $p < .001$, *95% C.I.* = [0.17,0.51]), six (*Estimate* = 0.78, *S.E.* = 0.08, $p = .004$, *95% C.I.* = [0.62,0.95]), nine (*Estimate* = 1.00, *S.E.* = 0.08, $p < .001$, *95% C.I.* = [0.84, 1.16]), 12 (*Estimate* = 1.02, *S.E.* = 0.08, $p < .001$, *95% C.I.* = [0.86, 1.19]), and 24 (*Estimate* = 1.01, *S.E.* = 0.08, $p < .001$, *95% C.I.* = [0.85, 1.17]) months. However, the children's HAZ increased from birth at three (*Estimate* = 0.38, *S.E.* = 0.07, $p < .001$ 95% *C.I.* = [0.24, 0.52]) and six (*Estimate* = 0.28, *S.E.* = 0.07, $p < .001$, *95% C.I.* = [0.14, 0.43]) months, but did not significantly change from birth at nine, 12, or 24 months (See Fig. 1).[1]

At 24 months post-birth, 8% of children were stunted, 3% of children were severely underweight for age, and 4% were wasted. Although the mean WAZ (mean difference = 0.18, $p = .001$, *95% C.I.* = [0.07, 0.30] and WHZ (mean difference = 0.33, $p < .001$, *95% C.I.* = [0.21, 0.46]) were significantly above the WHO norms at 24 months, the mean HAZ was significantly lower than the WHO norm (mean difference = −0.22, $p = .001$, *95% C.I.* = [−0.34, −0.09]), indicating stunted children who were for the most part not underweight.

4. Discussion

The rate of perinatal depression in the Eastern Cape (16%) is much lower than rates reported by previous research in rural, urban, and peri-urban areas in South Africa (>30%) (Honikman et al., 2012; Rochat et al., 2011; Rotheram-Borus et al., 2011). Unlike evidence from HIC (Brand and Brennan, 2009; Diego et al., 2004; Steer et al., al.,1992) and in some LMIC (Stein et al., 2014; Fisher et al., 2012; Nasreen et al., 2010; Patel et al., 2003), perinatal maternal depressed mood was not associated with negative growth outcomes for children in rural South Africa. The number of infants with low birth weights, as well as height and weight scores were consistent between children of mothers with and without perinatally depressed mood. These findings are consistent with a previous report on infant growth at 18 months among women who reported depressed mood two months after the birth of their child in peri-urban settlements outside of Cape Town, South Africa (Tomlinson et al., 2006).

Children of mothers with and without perinatally depressed mood had similar growth rates and developmental outcomes. At two years, the rates of both stunted (8%) and malnourished (3%) children were much lower in the currently studied rural region than the national averages (27% and 12%, respectively) (State of the World's Children, 2009). Mechanisms suggested to explain the effects of maternal depression on child development focus on individual deficits in caregiving (Stein et al., 2014). However, such deficits may be mitigated by the social connections rural living demands and more intact social structures when compared to peri-urban townships. (Patel et al., 2003).

The rural environment may offer social protective factors in managing depression and other difficulties faced by women. Geographically isolated areas, such as those in the Eastern Cape, foster social connections among the inhabitants to support survival (Schatz et al., 2011). Less than half of all mothers in the current cohort have household incomes above 2000 ZAR (154 USD) and at least two years pass until most mothers secure a child support grant to support their children and themselves. Also, their relationships with their partners are unstable as only one in three pregnant women live with their partners or their partner's families and one in five pregnant mothers experience violence by their partners. These challenges demand women to help each other for survival including caregiving children other than their own (Emmott, 2016; Rahman et al., 2003). One in three children experienced alloparenting in the current cohort. Further, mothers were also equally likely to breastfeed whether they reported depressed mood at birth or not. The more extreme poverty of rural communities may be associated with mothers, even those experiencing perinatal depressed mood, breastfeeding more because they have limited access to milk formula. Previous research in rural communities in South Africa and other LMICs suggest that social connections may mitigate the disruption caused by depression (Rahman et al., 2003). These connections are especially vital for mothers living in poor, rural areas with limited income, structural resources, and limited access to healthcare.

However, the influence of social support on maternal mental health in deeply rural areas of sub-Saharan Africa is not well understood

[1] Longitudinal regression models were also run with maternal EPDS scores (continuous variable) and similar results were found for child growth over the first two years (see Appendix A).

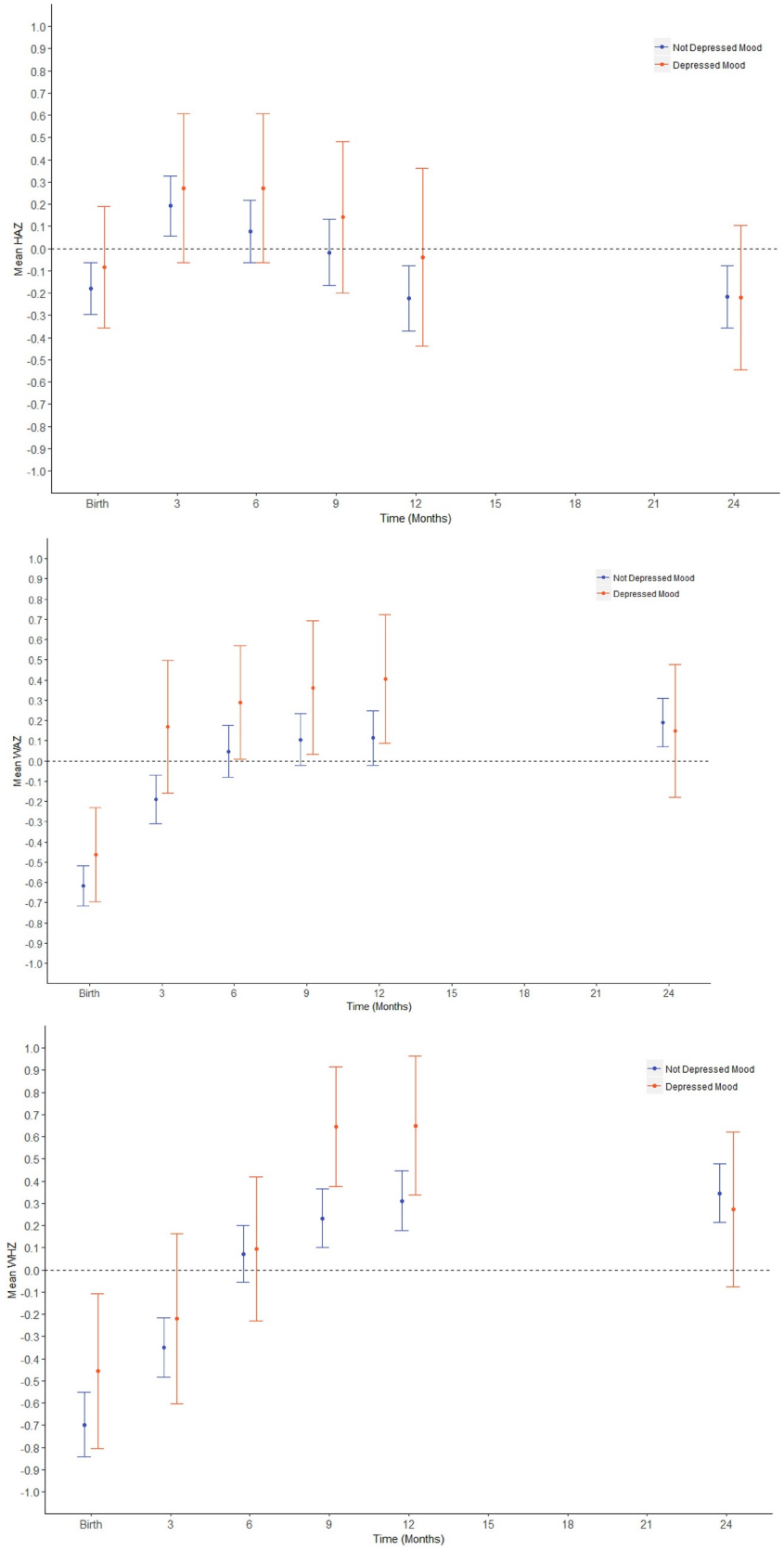

Fig. 1. Growth of children (HAZ, WAZ, WHZ scores) from birth to 24 months by Mothers' Depressed Mood at Birth. Longitudinal linear models were adjusted for household income, child gender, as well as living with the father or in-laws and IPV.

(Rochat et al., 2006; Vyavaharkar et al., 2010). Results from previous studies suggest the importance of measuring different forms of social support as not all have positive associations with better mental health (Rochat et al., 2006). Specifically, among pregnant women in rural KwaZulu-Natal in South Africa, living away from a family or parental home is related to more depression (Vyavaharkar et al., 2010). However, qualitative results suggest that having an unsupportive partner and familial conflict, sometimes related to unwanted pregnancies or HIV status disclosure, results in elevated emotional stress and depressive symptoms among pregnant women (Vyavaharkar et al., 2010). However, the association between these sources of social support and mental health has not been studied in the Eastern Cape to date.

5. Limitations

Although social support may serve as a protective factor for women experiencing perinatal depression in rural SA, the current study did not assess or measure the types or degree of social support experienced by the mothers. However, previous research in rural regions of both HIC (Emmott, 2016) and LMIC (Rochat et al., 2011) report associations between family and social support and reduced rates of ante- and postnatal depression. This highlights the need for future assessments to include measures of social support. Further, the current study assessed depressed mood at a single time-point, limiting the current analysis to maternal mood during the perinatal period. Although the EPDS has been found reliable and valid in South Africa (Hartley et al., 2011; De Bruin et al., 2004), it does not confirm a diagnosis of depression. Despite this limitation, the EPDS cut-off value of 13 serves as useful screening tool for depressed mood (Kheirabadi et al., 2012). This efficient and inexpensive screening tool is especially useful in contexts, such as deeply rural areas, where clinical diagnoses are difficult and costly due to a lack of access to healthcare professionals. Although we focus on examining the influence of perinatal depressed mood, future examinations may also consider the potentially varying effects of prenatal, perinatal, and postnatal depressed mood (Tarabulsy et al., 2014) on maternal and child outcomes in deeply rural settings.

6. Conclusion

Despite the lower rates of depression among pregnant women in rural versus peri-urban South Africa (Honikman et al., 2012; Rochat et al., 2011; Rotheram-Borus et al., 2011), mothers that experienced depressed mood perinatally faced even more deprivation than mothers without depressed mood. Mothers with perinatal depressed mood at the birth of their child had lower incomes, were less likely to live with their partner or their partner's family and more likely to experience IPV. These results are consistent with previous findings linking poverty (Lund et al., 2010), marital status (Simon, 2002), and IPV (Tsai et al., 2016) to an increased risk of depression during pregnancy. Furthering our understanding of how social connections work in this region and how they can be encouraged to promote healthy life choices may be especially important for geographically isolated areas in SA and other LMIC.

Conflict of Interest Statement

All authors declare no conflicts of interests.

Author Disclosures

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Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The study was conducted with approval of the Institutional Review Board of the Stellenbosch University (N12/08/046) and permission was granted by the Eastern Cape Department of Health to recruit in government health facilities.

Author contributions: JC conducted all the data analyses, prepared the first draft of the manuscript, and assisted in editing the manuscript. KLR, ILR, and MJRB developed the original project idea, obtained funding, oversaw project activities and participated in the drafting and editing of the manuscript. MT and ILR was involved in the original conception of the project and participated in drafting the manuscript. LSK was involved in the implementation of the project in the field and assisted in editing the manuscript. All authors read and approved the final manuscript.

Informed consent: Informed consent was obtained from all individual participants included in the study.

Availability of data and materials: Data can be made available upon request.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jad.2019.01.019.

Appendix A. Summary of fixed effects (with 95% confidence intervals) of timepoint and EPDS scores at birth on child growth

	EPDS score Estimate (SE)	95% C.I.	3 Months Estimate (SE)	95% C.I.	6 Months Estimate (SE)	95% C.I.	9 Months Estimate (SE)	95% C.I.	12 Months Estimate (SE)	95% C.I.	24 Months Estimate (SE)	95% C.I.
HAZ	0.01 (0.01)	-0.01, 0.02	0.38 (0.07)***	0.25, 0.52	0.29 (0.07)***	0.15, 0.44	0.16 (0.08)*	0.01, 0.31	−0.03 (0.08)	-0.20, 0.13	−0.04 (0.08)	−0.01, 0.02
WAZ	0.01 (0.01)	-0.01, 0.02	0.46 (0.05)***	0.38, 0.55	0.71 (0.05)***	0.60, 0.82	0.81 (0.06)***	0.69, 0.92	0.73 (0.06)***	0.61, 0.86	0.79 (0.06)***	0.68, 0.91
WHZ	−0.00 (0.01)	-0.02, 0.01	0.34 (0.08)***	0.17, 0.50	0.77 (0.08)***	0.61, 0.93	0.99 (0.08)***	0.84, 1.15	1.02 (0.08)***	0.85, 1.18	1.02 (0.08)***	0.85, 1.18

Note. There were no statistically significant ($p > .05$) interactions between EPDS score and timepoint.
*$p < .05$; ***$p < .001$.

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